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MYCOTAXON

AN INTERNATIONAL JOURNAL FOR RESEARCH ON
TAXONOMY & NOMENCLATURE OF FUNGI, INCLUDING LICHENS

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A NEW SPECIES OF PLEUROTHECIOPSIS FROM LEAF LITTER

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3) Instituto de Investigaciones Forestales, Playa, Ciudad de La Habana, Cuba.

ABSTRACT

Pleurotheciopsis tropicalis anam. sp. nov., found on decaying leaves of *Calophyllum antillanum* Britton in a tropical rainforest, is described and illustrated. This species is distinguished by cylindrical, pale brown, 3-septate conidia produced in unbranched acropetal chains. Notes on previously described species of *Pleurotheciopis* are given.

Key Words: ***Pleurotheciopsis tropicalis,*** hyphomycetes, leaf litter, systematics, tropical fungi, Cuba

INTRODUCTION

The genus ***Pleurotheciopsis*** B. Sutton (1973) is distinguished by distinct, single, brown to dark brown conidiophores and holoblastic, sympodial, integrated, denticulate conidiogenous cells. The denticles are cylindrical, flat, sometimes inconspicuous, and sloping, giving a rachiform appearance to the conidiogenous cells. Conidia are septate, dry, colourless, truncate at each end, and formed in unbranched acropetal chains. Sutton (1973) remarked that no pigment develops even in older conidia of ***P. pusilla*** B. Sutton (1973) (the type species) and ***P. bramleyi*** B. Sutton (1973). Also, this feature occurs in ***P. websterii*** Cazau *et al.*(1993). However, a specimen of the latter collected by the senior author on rotten stems of unidentified Poaceae in Farena, Tarragona, Spain (MUCL 40010), had conidia with yellow to very pale brown central cells. Similar pigmentation was observed in ***P. sylvestris*** R. F. Castañeda & Iturr. (1999) which had conidia with slightly pigmented central cells. Thus the generic concept has effectively been emended to include species with pigmented conidia. The taxon newly described below can be accommodated in *Pleurotheciopsis*, but differs significantly from any of those previously placed in this genus.

TAXONOMIC PART

Pleurotheciopsis tropicalis R. F. Castañeda et Calduch anam. sp. nov. Figs.1-2
Etym. L. *tropicalis* – refers to its occurrence in tropical areas.

Ad fungus conidiales, hyphomycetes pertinens. ***Coloniae*** *in substrato naturali pilosae, effusae, amphigenae, atrobrunnea. Mycelium plerumque superficiale et aliquot in substrato immersum, ex hyphis septatis, ramosis, laevibus, brunneis, 2.0-4.5 µm diam. compositum.* ***Conidiophora*** *macronematosa, mononematosa, erecta, recta, 11-22-septata, non-ramosa, sed raro brevissima ramosa circa apicem, 210-400 µm alta, 11-22 µm crassa ad basim, atrobrunnea vel nigra ad basim, pallide brunnea ad apicem, plerumque regenerata prope apicem, cum 1-3 proliferationibus percurrentibus.* ***Cellulae conidiogenae*** *terminales, sympodiales, polyblasticae, denticulatae, cum cicatricibus declivibus e denticulis 0.5-3.0 x 2-3 µm; dilute brunneis, 21-35 x4-5 µm, in conidiophoris incorporatae.* ***Conidiorum secessio*** *schizolytica.* ***Conidia*** *holoblastica, blastocatenata, non-ramosa, cylindrica, dilute brunnea, sicca, levia, conidia intercalaria utrimque valde attenuata e truncata, 2-3(plerumque 3)-septata, 25-40 x 2.5-3.0 µm, conidia primaria subulata e truncata ad basim, valde attenuata ad apicem, 3-septata,32-44 x 3 µm.* ***Teleomorphosis ignota.***

Matrix: *In foliis dejectis Calophylli antillani* Britton.
Habitat: *In sylva pluvialis*, Km 15, Viñales, Pinar del Rio, Cuba. *Legit:* R.F. Castañeda, 10-X-1997.
Holotypus: INIFAT C97/93, Santiago de Las Vegas, Cuba.
Isotypus: MUCL 40702.

Conidial fungi, hyphomycetes. Colonies on the natural substratum hairy, effuse, amphigenous, dark brown. Mycelium mostly superficial. Hyphae septate, branched, smooth-walled, brown, 2.0-4.5 µm diam. **Conidiophores** distinct, single, erect, straight, 11-22-septate, 210-400 µm tall, 11-22 µm wide at the base, unbranched, rarely with very short branches near the apex, dark brown to black below, pale brown toward the apex, with 1-3 percurrent proliferations. **Conidiogenous cells** integrated, sympodial, polyblastic, pale brown, 21-35 x 4-5 µm, terminal, denticulate, with flat, sloping scars 0.5-3.0 x 2-3 µm. **Conidial secession** schizolytic. **Conidia** holoblastic, blastocatenate, cylindrical, very pale brown, dry, smooth-walled, primary conidia subulate and truncate at the base, strongly attenuate to constricted at the apex, 3-septate, 32-44 x 3 µm; intercalary conidia strongly attenuate to constricted and truncate at the ends, 2-3 (mostly 3)-septate, 25-40 x 2.5-3.0 µm. **Teleomorph unknown.**

Substrate: On fallen, decaying leaves of *Calophyllum antillanum* Britton.
Habitat: In undisturbed rainforest, Km 15, Viñales, Pinar del Rio, Cuba. *Leg.* R.F. Castañeda, 10- X -1997.
Holotype: INIFAT C97/93, Santiago de Las Vegas, Cuba.
Isotype: MUCL 40702.

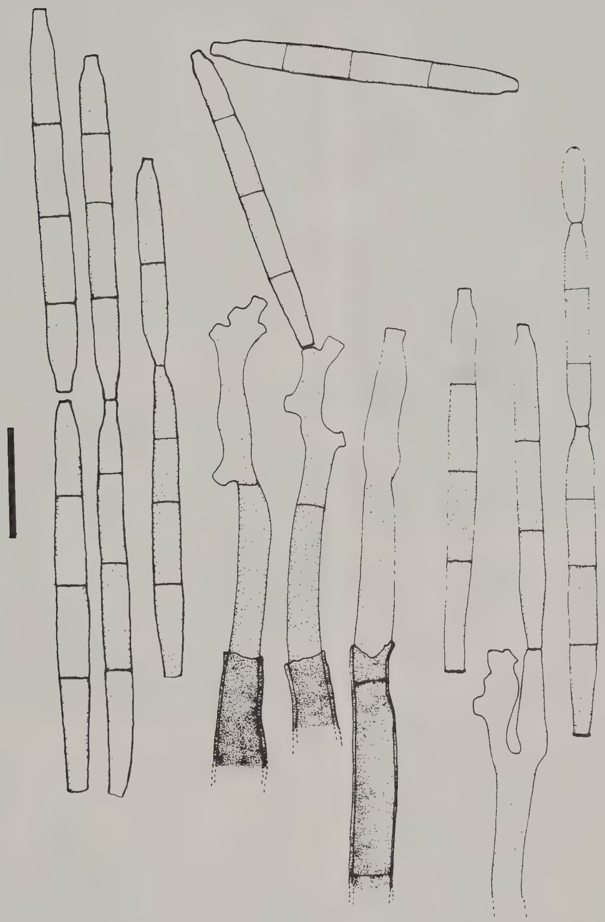

Fig 1. ***Pleurotheciopsis tropicalis*** (INIFAT C97/93). Conidiophores, conidiogenous cells and conidia (bar = 10 µm).

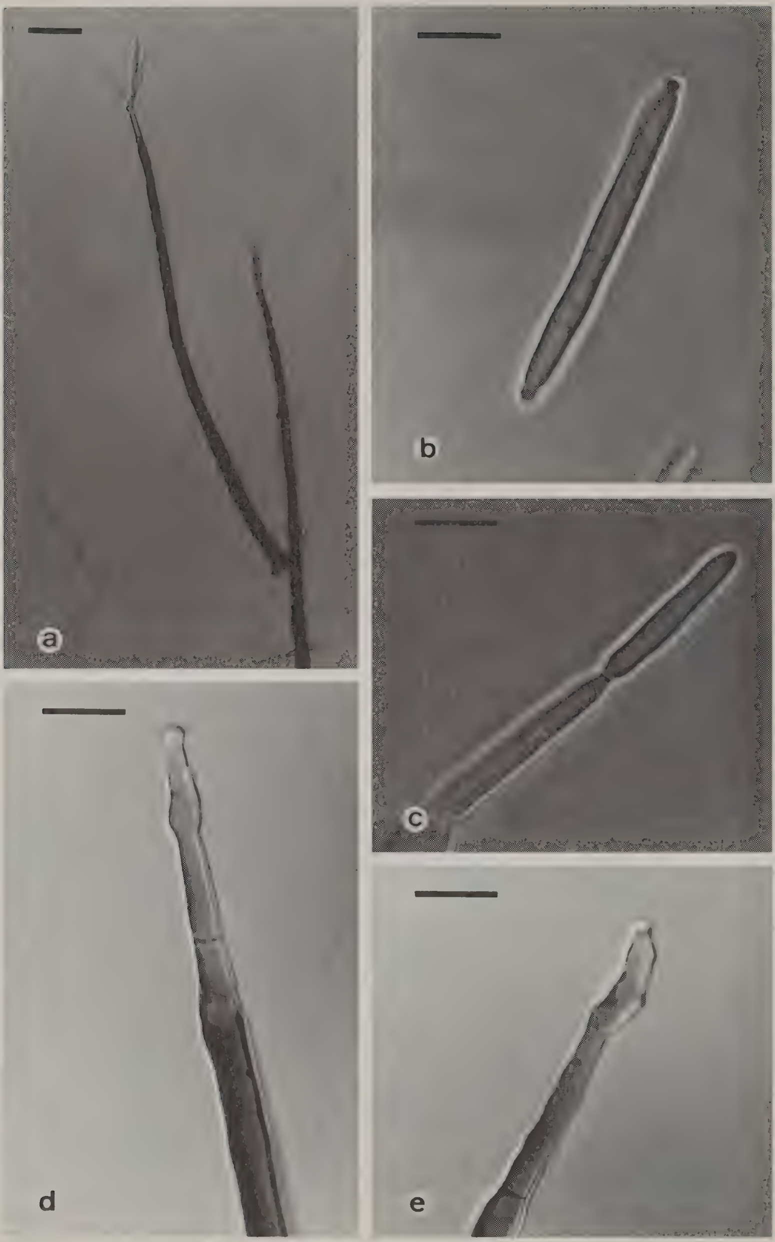

Fig 2. ***Pleurotheciopsis tropicalis*** (INIFAT C97/93). **a**. Conidiophores; **b**. Conidia; **c**. Acropetal chains of the conidia; **d**, **e**. Detail of the conidiophore with conidiogenous cells. Scale bars: a = 40 μm; b, c, d, e = 10 μm.

Colonies on V-8 agar attaining 25-35 mm diam. in 7 days at 25 °C, with brown aerial mycelium and dark brown reverse. Conidiophores arising perpendicularly from undifferentiated hyphae, and no proliferations have been observed. Conidia similar to those on the natural substrate, 3-5-septate, 35-57 x 3.0-4.5 µm.
Cultures deposited: INIFAT C97/93 = MUCL 40702 = CBS 100511.

Among previously described species of ***Pleurotheciopsis***, *P. tropicalis* resembles only *P. pusilla* in the shape of the conidia, but the latter has 1-(2)-septate, hyaline, conidia 6.5-12.5 x 2.0-2.5 µm. *P. setiformis* R. F. Castañeda (1985) has synchronous conidiogenous cells and setae around the conidiophores and could represent an undescribed new genus, so is not discussed in this paper.

Key to the accepted species of *Pleurotheciopsis*.

1 . Conidia cylindrical or slightly clavate....................2
1'. Conidia navicular to fusiform....................3
2 . Conidia 1(-2)-septate, hyaline, smooth,
    6.5-12.5 x 2.0-2.5 µm....................*P. pusilla*
2'. Conidia 3-septate, very pale brown, smooth,
    25-44 x 2.5-3.0 µm....................*P. tropicalis*
3 . Conidia 2-3-septate, hyaline or pale yellow at the middle, smooth,
    16.5-25.0 x 4.5-6.5 µm....................*P. bramleyi*
3'. Conidia with more than 3 septa....................4
4 . Conidia 5-septate, hyaline, smooth,
    32-38 x 5-6 µm....................*P. websterii*
4'. Conidia 4-7-(mostly 5)-septate, middle cells pale brown to yellow, smooth,
    29-49 x 7.0-8.5 µm....................*P. sylvestris*

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ASCOSPHAERA TORCHIOI SP. NOV., A PATHOGEN OF OSMIA LIGNARIA PROPINQUA CRESSON (HYMENOPTERA)

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ABSTRACT

Ascosphaera torchioi **sp. nov**. differs from other described *Ascosphaera* by having larger spores, and by having residual bodies that are present within and between the spore balls, and also on the inner wall of ascocysts. The fungus was found in mummified larvae of *Osmia lignaria propinqua*, a pollinator of orchard crops. The fungus induces symptoms characteristic of those *Ascosphaera* species that form ascocysts beneath the integument. Experimentally, ***A. torchioi*** was found to be pathogenic to *O. lignaria* and *O. californica.* Only germination of spores and minimal hyphal growth could be obtained on artificial culture media.

KEYWORDS: ***Ascosphaera torchioi*** **sp. nov**., Ascomycota, Ascosphaeraceae, *Osmia lignaria propinqua,* Chalkbrood Disease

INTRODUCTION

For centuries, the honeybee (*Apis mellifera* L.) has been recognized as the principle manageable pollinator of agriculture crops worldwide. Recently, it has been shown that its effectiveness varies with crop, season and geography. Since the late fifties, two species of bees other than the honeybee have been introduced as manageable pollinators (Bohart 1972). One of them, the alfalfa leafcutting bee, *Megachile rotundata*, is considered the most valuable pollinator of alfalfa in North America. With the recent decline in number of honeybee colonies, the increase in acreage of orchard crops in the USA, and the establishment of the Africanized honeybee in the southwestern USA, the search for alternative pollinators was accelerated. In response, Torchio (1981, 1982, 1984) has demonstrated successfully the potential of *Osmia lignaria propinqua* Cresson as an alternative pollinator in the commercial orchard environment.

When the incidence of the chalkbrood syndrome, caused by several species of *Ascosphaera* in managed populations of the alfalfa leafcutting bee threatened the alfalfa seed production industry, an interest in these fungi was generated (Vandenberg and Stephen 1982, McManus and Youssef 1984, Youssef et al. 1984, Rose et al. 1984). In the early eighties, in cooperation with personnel of the Bee Biology and Systematics Laboratory, USDA-ARS, Logan, Utah, we conducted an intensive survey of the Ascosphaeraceae associated with bee larvae. Special attention was given to *Osmia lignaria propinqua.* We recognized that knowledge of the Ascosphaerales pathogenic to this species would be of extreme importance to manage the species properly in commercial operations. In a cross infectivity study, we reported finding three species of *Ascosphaera* in natural populations of *O. lignaria propinqua* (Youssef et al. 1985). This paper describes one of these species of *Ascosphaera*, as a new species. The described species is the most prevalent pathogen encountered in natural and commercial populations of *O. lignaria propinqua.* We also describe its *in vivo* development and pathogenicity.

MATERIAL AND METHODS

Five hundred dead larvae of *O. lignaria propinqua* showing the typical syndrome associated with infection by *Ascosphaera* (dark metallic chalky appearance) were provided by Philip Torchio of the Bee Biology and Systematics Laboratory, USDA-ARS, Logan, Utah. These larvae were dissected out from hundreds of trap nests placed in Cache Valley, UT (for details refer to Torchio 1982). Based on size, microscopic examination of spores from each infected larva (Youssef et al. 1984) revealed the presence of an undescribed species of *Ascosphaera* in 496 of the larvae.

Infected larvae of *O. lignaria* were used as a source of inocula in the *in vivo* study. To avoid contamination with surface microbes found on larval integument, each of several infected larvae was embedded in melted parawax® (VWR, Denver, CO.) placed in a metallic mold. The melted wax was rapidly hardened by placing the molds in a freezer (≅ -20°C). The resultant wax blocks were kept in the freezer until usage. To prepare the inoculum, a wax block was cracked so that a cross section of the mummified larva would be exposed while the rest of it remained surrounded by the hardened wax, thus precluding surface contaminants. With the aid of a 28 gage sterilized needle, ascocysts were removed and placed in a 25 ml serum bottle containing sterilized distilled water. The bottles were sealed aseptically with serum bottle rubber septa. To break the ascocysts and to free the spores from the spore balls, the sealed bottles were placed in a water bath at room temperature and subjected to sonication for 5 min. Spore count per milliliter was determined with a hemocytometer and the final concentration was adjusted so that 0.1 ml would contain about 200,000 spores.

INOCULATION OF LARVAE: All attempts to culture this fungus have failed regardless of media type, pH, temperature, and gaseous environment. Only limited success in germinating the fungus was achieved when we used the plug/base medium used to culture another fastidious fungus, *Ascosphaera aggregata* Skou (Youssef and

McManus, 1991). Since we were not able to culture the fungus on culture media, we selected to study its life cycle *in vivo*, with emphasis on pathogenicity. To obtain young larvae and natural (pollen and nectar) provision, nest traps (soda straws placed in wooden blocks) similar to those described by Torchio (1981), were placed in an orchard in Northern Utah. Adult *O. lignaria propinqua* bees were then released and allowed to settle for 2-3 days. Nests were removed periodically and brought to the lab for further study. Nests were slit laterally and the exposed provisions with eggs were transferred to gelatin capsules.

Each provision was inoculated by a drop (0.1 ml) of inoculum containing about 10,000 spores. Gelatin capsules were placed in a rack and kept vertically at 20°C and a relative humidity of about 70%. Control samples were kept under the same conditions. Infected larvae were removed at day 2, 7, 9, 17, and 25 after inoculation and prepared for routine light and scanning electron microscopy. Samples were examined with an Olympus IM2 inverted light microscope. For scanning electron microscopy, pieces of cadavers of infected *O. lignaria propinqua* were mounted on appropriate holders, coated with gold, and were observed with a Hitachi S4000 field emission scanning electron microscope.

RESULTS

Ascosphaera torchioi, Youssef and McManus, sp. nov.

LATIN DIAGNOSIS: Ascocystae densae inventae sub cuticulari strato larvalis integumenti; metallicae fuscae aut nigrae; variabiles forma magnitudineque secundum locum intra larvis. Hae in interioribus posterioribusque finibus sunt parviores quam illae in mediis; amplitudo varians 175-353 x 423-892 μm, 311 ± 98 x 581 ± 219 μm; fragiles laevibus muris extra et lentiginosae habitu intra (Fig. 1), continentes aggregata globulorum sporarum. Globuli sporarum (Fig. 1), viriduli fusci, sphaerici 25 -30- 47 diam.; compacti et saepe velati multum particulata materia (Fig. 2). Ascosporae (Fig. 3) unicellulares translucentes pallide virides laevi pagina dispositae in forma sphaerae perfectae. Numerus sporarum per globulum sporarum extensus 32 - 128 (maior pars 64); amplitudine varians 11.0-12.4 x 3.5-3.9 μm (ratione longitudinis pro latitudine = 3.2), apicibus fusiformis plus minusve obtusis. Corpora residua (Figs. 1 & 4), sphaerica pagina aspera, inventa inter intraque globulos sporarum aut interiori pagina muri ascocystae; confertae electroniciis, amorphae structurae exanimatae ab TEM.

DESCRIPTION: *Ascocysts* found tightly packed beneath the cuticular layer of larval integument; metallic dark brown or black in color; variable in shape and size based on location within the larvae. Those in the interior and posterior ends smaller than those in the middle; size range, 173-353 x 423-892 μm, averaging 311 ± 98 x 581 ± 219 μm; fragile with smooth walls on the outside and dusty in appearance on the inside (Fig. 1), containing aggregates of spore balls. *Spore balls* (Fig. 1), greenish brown, globose (ranging from 25 to 47 µm and averaging 30 µm in diameter); compact and in many instances coated heavily with particulate matter (Fig. 2). *Ascospores* (Fig. 3) one-celled translucent pale green with a smooth surface arranged to form perfect spheres. Number of spores per spore ball ranged from 32 to 128 (majority 64); size range, 11.0-12.4 x 3.5-3.9 µm (length/width ratio = 3.2), fusiform with more or less obtuse apices. *Residual bodies* (Figs. 1 & 4), spherical with a rough surface, found within and between spore balls or on the inner surface of ascocyst wall; appearing as electron dense, amorphous structures when examined by TEM.

MATERIAL EXAMINED: Over 2,000 infected larvae of *O. lignaria* were examined. 20 infected larvae were designated as *holotype.* Larvae were placed individually in a gelatin capsule and deposited at the Intermountain Herbarium (UTC), Utah State University, 5305 Old Main Hill, Logan, Utah, with accession number 228011.

ETYMOLOGY: **Torchioi** is derived from the last name of Philip Torchio, the first to discover the infected larvae. He is also the scientist who pioneered the development of the host *Osmia lignaria propinqua* for pollination of orchard crops.

HABITAT: ***Ascosphaera torchioi*** was first observed in mummified last instar larvae of *Osmia lignaria propinqua* and *Osmia californica.* The dead larvae were isolated from trap nests set in several locations in Cache County, UT. The infected larvae were brittle, hard and had the color (metallic dark brown) of fungal ascocysts. Compared with healthy larvae, infected larvae appeared swollen from the numerous ascocysts that had developed beneath the integument. In cross or longitudinal sections, three-different layers were recognizable; a central core of pollen mass surrounded by remnants of the gut, a dense brown hyphal mat surrounding the pollen core and a single layer of tightly packed ascocysts beneath the remaining layer of larval integument. Hyphae and reproductive stages were never observed penetrating the integument.

CULTURE: Germination was obtained only on Agar-V8™ juice medium described by Papavizas and Davey (1959). The inoculated media were maintained under CO_2 for at least 24 hrs. At this time the spores doubled in size and each had two prominent nuclei. At 36 hr, one apical end elongated forming the hyphal filament, the hyphal filament stopped growing after 48 hrs reaching a length of about 70 - 120 µm. All attempts to culture the germinating spores on standard media such as PDA, PDA/Yeast, SDA, and on modified media such as plug/base media (Youssef and McManus 1991), and MEA with 30% glucose (Skou and King 1984) have failed so far. Only when we used *in vivo* culture were we able to study the life cycle of the fungus from spore to spore. Mode of entry of the fungus, invasion of host cell, proliferation of vegetative growth and reproductive life cycle were similar to the *in vivo* life cycle of *A. aggregata* in the larvae of the alfalfa leafcutting bee, *Megachile rotundata* (McManus and Youssef 1984). The spores germinated in the larval gut. Upon germination, the developing hyphae penetrated the gut wall and began to develop in larval hemocoel invading every tissue.

Within a week or two (depending on the temperature), larval tissues were replaced with fungal hyphal mats. Two weeks later, ascocysts became apparent under the integument and within three weeks, they darken giving the larvae its dark brown metallic color.

PATHOGENICITY: Our *in vitro* study proved the fungus is a parasite of *Osmia lignaria propinqua.*

DISCUSSION

Morphology, culture, and pathogenicity were sufficient to differentiate *Ascosphaera torchioi* from other described Ascosphaerales. On morphological grounds, the described species is unique. The average spore size (11.7 x 3.7 μm) is much larger than that of any other *Ascosphaera* species. Of the described species, *A. cinnamomea* and *A. parasitica* have the largest spore sizes averaging 7.9 x 2.1 μm and 6.5 x 1.7 μm respectively. However, the biology of *A. cinnamomea* Skou and *A. parasitica* Skou is very different than that of *A. torchioi.* According to Skou (1988), *A. cinnamomes* is a saprophyte. *A. parasitica* was found within the cocoon of *Osmia cornifrons.* Dead larvae were interwoven by only mycelia without ascocysts. The cysts were on the inner side of the cocoon either in close proximity to each other forming close aggregates or found singularly. Both species were found in nests obtained from Japan. In contrast, all larvae showing characteristics of the disease induced by *A. torchioi* contained ascocysts beneath larval integument.

Another morphological feature that is of interest is the presence of “residual bodies”. These were apparent upon examination of ascocysts with SEM and TEM. The term “residual bodies” refers to the amorphous globose structures that were found within the spore balls, between them, and/or on the inner wall of the ascocysts (Figs. 1 & 4). These bodies are probably of the same origin as the particulate material covering the outside layer of spores forming spore balls. These bodies were not seen in any published monographs (McManus and Youssef 1984, Bissett 1988, Skou 1988) or described previously in other *Ascosphaera,* including *A. cinnamomea* and *A. parasitica.* With regard to culture, *A. torchioi* was fastidious in contrast to six of the seven *Ascosphaera* species found in nests of *Osmia cornifrons*, which is a close relative of *O. lignaria propinqua.* These six species were easy to culture on artificial media (Skou 1988), which is typical of *Ascosphaera* species that are saprophytes. The life-cycle study presented here indicated that *A. torchioi* is a pathogenic species.

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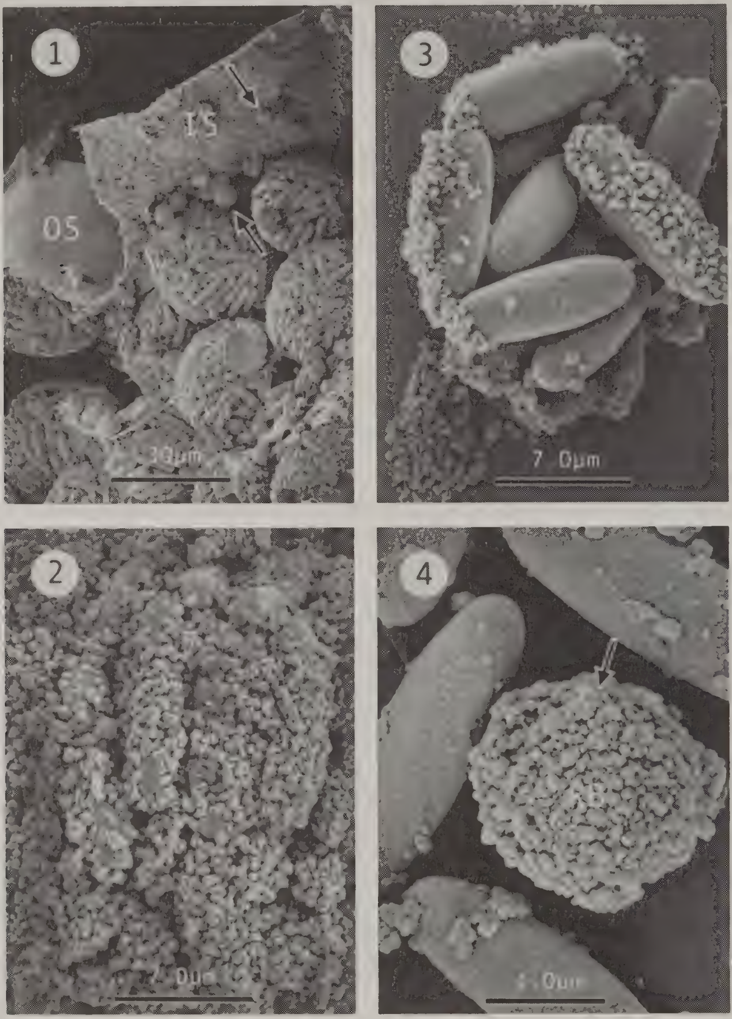
and Frank Parker (40 infected larvae), formerly of the Bee Biology and Systematics Laboratory, USDA-ARS, Logan, Utah.



Figs. 1-4. SEM micrographs of ascocysts, spore ball and ascospores of *A. torchioi.* 1: Cracked ascocyst showing the smooth outer surface (OS), rough inner surface (IS), spore balls (SB), and residual bodies (RB). 2: Portion of a spore ball; note particulate on spore surface. 3: Ascospores; note smooth surface. 4: Ascospores and a residual body.

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APHYLLOPHORACEOUS WOOD-INHABITING FUNGI OF THE LANAITTU VALLEY (NUORO), SARDINIA

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ABSTRACT

Some of the most interesting Italian aphyllophoraceous wood-inhabiting fungi have been collected in the Lanaittu Valley. At the end of 1999, collections were recorded representing 44 species from 30 genera. The valley has typical Mediterranean vegetation with some multicentenarian *Juniperus phoenicea* and *J. oxycedrus* subsp. *macrocarpa* trees.

Key words: Aphyllophorales, wood-inhabiting fungi, Sardinia.

INTRODUCTION

Lanaittu Valley is part of the Oliena Mountain Range (Figure 1) which is made up of a sequence of dolomite and limestone of Upper Jurassic and Lower Cretaceous. The present conformation and the evolution of Lanaittu Valley is the consequence of geological and geomorphological events followed in the Supramonte Area from the Tertiary period onward.

Flora and vegetation are quite peculiar and create a real island in the Sardinian-Corsican continent and differ from those of the nearby Gennargentu with geological structures of Paleozoic (granites and schists).

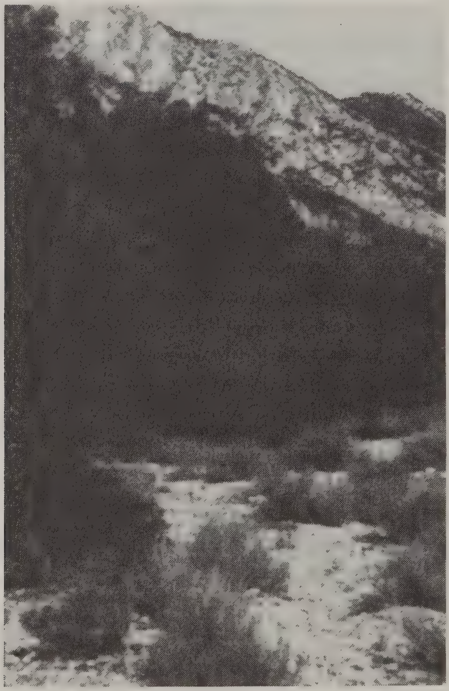

Figure 1: Oliena Mountain Range (Photo F. Padovan).

At the base of the Oliena Mountain Range, which is a calcareous alluvial cone, a *Quercus ilex* wood has spread from sea level to the base of the high mountains (Figure 1). However the ground cover is scanty due to poor humus and the stony ground. The rocky walls are typically inhabited by rocky vegetation with some endemisms that are peculiar to these mountains. *Oleo-Juniperetum phoeniceae* Arrigoni, Brubo, De Marco e Veri or to *Pistacio-Quercetum ilicis* Brullo and Marcenò = *Viburnum-Quercetum ilicis pistacietosum* sensu Arrigoni flourish in the Lanaittu Valley.

The valley has a hot and arid climate which aids the development of thermo-xerophyte Mediterranean vegetation. The soil erosion and the denuded substratum generates strong light and heat reflection off the white calcareous rocks causing water loss and high temperatures during the day (Arrigoni & Di Tommaso, 1990/1991).

Five excursions have been accomplished, and all during November and December. All the specimens collected by the author are deposited in H.U.B.O. The nomenclature follows that of Burdsall (1985), Donk (1984), Eriksson et al. (1973, 1975, 1976, 1978, 1981, 1984, 1988); Hjortstam (1998); Ryvarden & Gilbertson (1993, 1994); Parmasto (1997).

The species are listed in alphabetic order. For a detailed description I refer to specialised texts while here only interesting species will be expounded.

The cartographic number of Lanaittu Valley is: IGM 1:25,000, 5003.

CHECKLIST OF COLLECTED APHYLLOPHORALES

Amaurodon viridis (Alb. & Schwein.) J. Schröt., 13.12.97, coll. 7001. The specimen was growing at or below the soil line of *Rosmarinus officinalis*. It is a rare species in Italy, collected only twice, and both in Sardinia.

Antrodia albida (Fr.) Donk, 20.11.99, coll. 7221, 7229 on branch and stump of *Phillyrea latifolia*.

Antrodia sp., 11.11.94, coll. 6659 on a small branch of *Phillyrea latifolia* lying on the ground. It is an unrecorded species (close to *A. macra*, L. Ryvarden pers. comm.) but with ellipsoid basidiospores that don't fit with any other species of *Antrodia* and with 3-4 pores per mm.

Antrodia macrospora Bernicchia & De Dominicis, 6.12.96, 13.12.97, 20.11.99, coll. 6846, 6912, 7034, 7244, on dead but still attached branches of *Phillyrea latifolia*. It is a typical Mediterranean species (Figure 2).

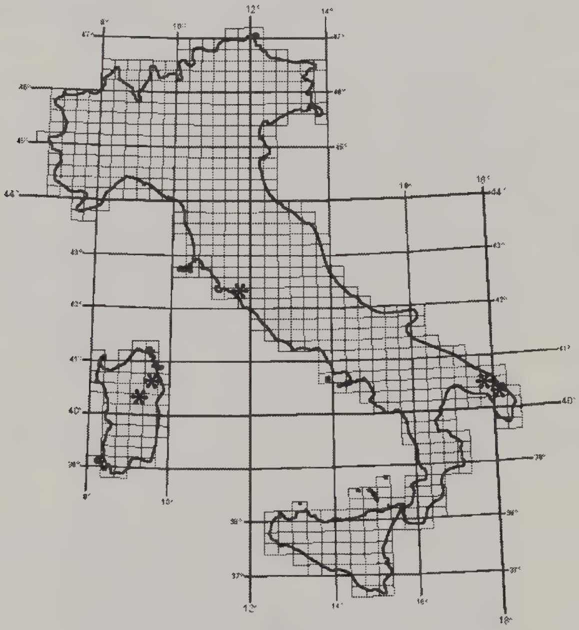

Figure 2: Distributional map of *Antrodia macrospora*.

Asterostroma cervicolor (Berk. & M.A. Curtis) Massee s.l., 11.11.94, 13.12.97, coll. 5693, 6600 to the root neck of *Helichrysum*. It is a rare species in Italy with only few collecting reports and a distributional range in the Mediterranean area.

Byssomerulius corium (Fr.) Parmasto, 20.11.99 coll. 7243, on twigs of *Quercus ilex*.

Ceriporiopsis gilvescens (Bres.) Domañski, 20.11.99, coll. 7250, on dead branches of *Pistacia lentiscus*.

Coniophora arida (Fr.) P. Karst., 13.12.97, coll. 7103 on lying, dead stems of *Juniperus phoenicea*.

Corticium roseum Pers., 20.11.99, coll. 7234, on twigs of *Pistacia lentiscus*.

Dendrothele nivosa (Höhn. & Litsch.) P.A. Lemke, 07.12.96, 13.12.97, 20.11.99, coll. 6853, 6857, 7242, 7257 on branches and stems of *J. phoenicea*. Previously it seemed to be a rare species. Now it is possible to find it in the Central and Southern parts of Italy, both on *J. oxycedrus* and *J. phoenicea*.

Dichomitus campestris (Quél.) Domañski & Orlicz, 20.10.99, coll. 7241 on dead branches of *Q. ilex*.

Echinodontium ryvardenii Bernicchia & Piga, 13.12.97, 20.11.99, coll. 6908, 7238, on branches and stems of an old *J. phoenicea*. It is a most interesting species (Bernicchia & Piga, 1998). Other collections have been done at Capo Comino (Nuoro), type species, coll. 6907, and at Portixeddu (Cagliari). It is the only species of *Echinodontium* collected in Europe. The others are growing in North America and Asia.

Ganoderma australe (Fr.) Pat., 20.11.99 coll. 7240 at the base of a dead *Q. ilex*.

Gloeophyllum sepiarium (Wulf.) P. Karst., 13.12.97, 20.11.99, coll. 6991, 7238 on dead lying trunks of *J. phoenicea*.

Henningsomyces candidus (Pers.) Kuntze, 11.11.94, coll. 6626 on twigs of *Cistus salvifolius*.

Hyphoderma praetermissum (P. Karst.) J. Erikss. & Å. Strid, 11.11.94, 20.11.99, coll. 6698, 7236 on twigs of *Helichrysum* and *Rosmarinus*.

Hyphodermella corrugata (Fr.) J. Erikss. & Ryvarden, 11.11.94, coll. 6602 on stems of *Rosmarinus*.

Hyphodontia crustosa (Pers.) J. Erikss., 11.11.94, coll. 6608 on stems of *Cistus salvifolius*.

Hyphodontia juniperi (Bourdot & Galzin) J. Erikss. & Hjortstam, 2011.99, coll. 7235 on *J. phoenicea*.

Hyphodontia sambuci ((Pers.) J. Erikss., 11.11.94, coll. 6664 at or below the soil line of *Helichrysum*.

Kavinia himantia (Schwein.) J. Erikss., 13.12.97, coll. 7029 under a lying trunk of *J. phoenicea* in a very moist and mossy hollow present on the ground.

Peniophora lycii (Pers.) Höhn. & Litsch., 20.11.99, coll. 7233 on *J. phoenicea*.

Peniophora meridionalis Boidin, 07.12.96, 20.11.99, coll. 7248, 7271 on twigs of *Phillyrea latifolia*.

Peniophora quercina (Pers.) Cooke, 20.11.99, coll. 7228 on branches of *Q. ilex*.

Peniophora versicolor (Bres.) Sacc. & Sydow, 7.12.96, 20.11.99, coll. 7192, 7226 on stems of *Phillyrea* and *Rosmarinus*.

Perenniporia rosmarini A. David & Malençon, 11.11.94, 07.11.96, coll. 6601, 6622, 6844 on stems and branches of *Rosmarinus officinalis* and *J. phoenicea*, sometimes to the root-neck. It is very frequently collected on living shrubs.

Phanerochaete velutina (DC.) P. Karst., 13.12.97, coll. 7255 on a branch of *Q. ilex*.

Phellinus juniperinus Bernicchia & Curreli, 13.12.97, coll. 7032 at the base of a living *J. phoenicea*. It has recently been collected in the Southern part of France (Pieri, pers. comm.).

Phellinus rosmarini Bernicchia, 11.11.94, 07.12.96, 13.12.97, coll. 6623, 6989, 7028, 7270 at the base of trunks of *Rosmarinus officinalis* and *Pistacia lentiscus*. It has always been collected on shrubs, never on trees.

Phellinus torulosus (Pers.) Bourdot & Galzin, 20.11.99, coll. 7231 at the base of *J. phoenicea*.

Polyporus meridionalis (A. David) H. Jahn, 20.11.99, coll. 7252 on *Cistus*.

Polyporus tuberaster Jacq., 20.11.99, coll. 7230 on *Phillyrea latifolia*.

Steccherinum fimbriatum (Pers.) J. Erikss., 11.11.94, 07.12.96, coll. 6697, 6837, 6858 at or below the soil line of *Helichrysum*.

Thanatephorus orchidicola Warcup & P.H.B. Talbot, 13.12.97, coll. 6911 to the root neck of *Rosmarinus*. It is a very rare species in Italy. Conf. P. Roberts.

Thanatephorus sterigmaticus (Bourdot) P.H.B. Talbot, 13.12.97, coll. 7002 to the root neck of *J. phoenicea*. It is a very rare species with only one collecting locality. It is probably new to Italy.

Trametes junipericola Manjon, G. Moreno & Ryvarden, 13.12.97, coll. 6916 on trunks and branches of *J. phoenicea* (Manjon & Moreno, 1981). It is the first collection from Italy. The species is fertile during the late Autumn but is soon destroyed by insects.

Trametes versicolor (L.) Pilat, 07.12.96, coll. 6842 on *Phillyrea latifolia*.

Trechispora confinis (Bourdot & Galzin) Liberta, 13.12.97, coll. 6994, on *J. phoenicea*.

Trechispora praefocata (Bourdot & Galzin) Liberta, 11.11.94, coll. 6624 on *Pistacia lentiscus*.

Tulasnella violea (Quél.) Bourdot & Galzin, 13.12.97, coll. 7005 on stems of *Phillyrea latifolia*.

Vararia gallica (Bourdot & Galzin) Boidin, 11.11.94, coll. 6672 below the soil line on *Helichrysum.*

Vararia maremmana Bernicchia, 07.12.96, 13.12.97, 20.11.99, coll. 6852, 6997, 7227 on stems of *J. phoenicea*.

Vuilleminia megalospora (Bres.) Bourdot & Galzin, 07.12.96, 20.11.99, coll. 6833, 6836, 6848 on branches of *Q. ilex*. This species was previously collected by the author at only a few localities in Sardinia.

Xylobolus subpileatus (Berk. & M.A. Curtis) Boidin, 11.11.94, coll. 6625 on stem of *Helichrysum*.

CONCLUSIONS

From an ecological point of view, I must emphasise that most of the species were collected on *Juniperus phoenicea* and *Phillyrea latifolia* while many of the species collected on *Rosmarinus* and *Helichrysum* were growing at or below the soil line. When rare bushes dry up, they easily get carried away by the wind. In fact it is not difficult to see big, dry bushes, formed as a ball, rolling away during windy days. Few species are collected in Lanaittu Valley due to the aridity of the area and the high temperatures. However the collected species are most interesting. For example: *Thanatephorus orchidicola*, *T. sterigmaticus* and *Trametes junipericola*. Moreover, *Phellinus juniperinus*, *Ph. rosmarini* and *Echinodontium ryvardenii* are rare species with occurrences in this valley. I am sure that, during misty still Autumns, that are very rare in Sardinia indeed, it should be possible to collect many more and interesting species.

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TWO NEW SPECIES OF THE LICHEN GENUS MYELOCHROA (PARMELIACEAE, ASCOMYCOTA) FROM CHINA

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ABSTRACT: Two new lichen species are described from China: *Myelochroa salazinica* S. L. Wang, J. B. Chen & Elix and *M. sinica* S. L. Wang, J. B. Chen & Elix. *Myelochroa salazinica* is the first species of this genus known to contain salazinic acid as the major medullary constituent.

KEYWORDS: new species, *Myelochroa salazinica*, *Myelochroa sinica,* China

Introduction

The genus *Myelochroa* was recently established (Elix & Hale 1987; Elix 1994) to accommodate species which differed from all the other members of *Parmelina* sens. lat. in having a yellow-orange medulla (at least in part) due to the presence of secalonic acids and in containing hopane triterpenes. At that time 19 species were recorded for the genus, which had a predominantly East Asian - North American distribution. Since that time several new species and new combinations of *Myelochroa* have been reported, including *M. coreana* Park (1990), *M. nothofagi* Elix (1996), *M. siamea* Kurokawa (1998), and *M. crenulata* (Zhao) Hale ex De Priest & B. W. Hale (1998). In addition, *Myelochroa immiscens* (Nyl.) Elix & Hale and *M. lindmanii* (Lynge) Elix & Hale have been transferred to *Parmotrema* (Kurokawa 1997) since these two species have rather broad lobes with a relatively wide erhizinate zone on the lower surface and lack triterpenes, which is constant in other members of *Myelochroa*. Consequently 21 species were accepted in this genus before the present study, and we are now describing two new species. Throughout the present work chemical constituents were identified by thin layer chromatography (Culberson 1972; Culberson & Johnson 1982; Elix & Ernst-Russell 1993), high performance liquid chromatography (Elix *et al.* 1997; Feige *et al.* 1993) and comparison with authentic samples.

New species

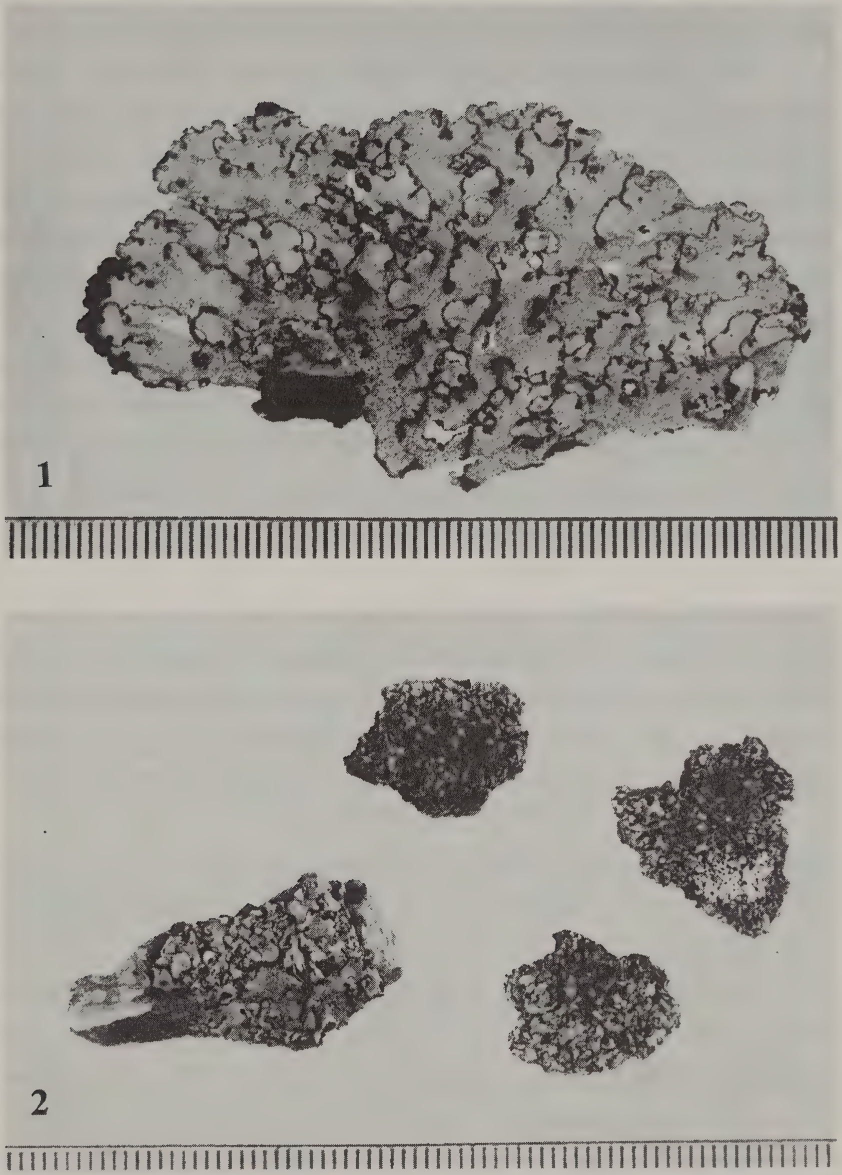
Myelochroa salazinica S. L. Wang, J. B. Chen & Elix, sp. nov. Fig. 1

Thallus ut in *Myelochroa metarevoluta* sed acidim salazinicum et acidum leucotylicum continente differt.

Type: CHINA. Yunnan: Mt. Gongshan, 1500 m, on rock, *J. J. Su 3224,* 23 Aug. 1982 (holotype: HMAS-L; isotype: CANB).

Thallus corticolous or saxicolous, foliose, adanate, 5-6 cm wide. *Lobes* imbricate, sublinear to subirregular, irregularly branched, apically subrotound, 2-8 mm wide; the margin ciliate, cilia simple, irregularly dispersed but mainly in the lobes axils, to 0.5 mm long. *Upper surface* pale mineral grey, flat, shiny, white-maculate, lacking isidia, submarginally sorediate, soredia coalescing into large subcapitate soralia. *Medulla* mostly white, pale yellow in some places. *Lower surface* black, brown in a narrow marginal zone; rhizines dense, black, simple. *Apothecia* and *pycnidia* not seen.

Chemistry. Cortex: K+ yellow; medulla K+ red C-, KC-, P+ yellow;



Figures 1-2. Two new species of *Myelochroa*. -1. *M. salazinica* (holotype); -2. *M. sinica* (holotype). Scales in 1 mm.

containing atranorin (minor), salazinic acid (major), consalazinic acid (minor), galbinic acid (trace), pigmentosin B (trace), zeorin (major), leucotylic acid (major).

The soralia present in this species closely resemble those of *Myelochroa metrevoluta* (Asah.) Elix & Hale but these species differ both chemically and morphologically. *Myelochroa metarevoluta* has dichotomously branched, sublinear-elongate lobes which are ascending at the apices, whereas the lobes of *M. salazinica* are sublinear to subirregular, irregularly branched, and flat and subrotund at the apices. Furthermore, *M. salazinica* contains salazinic acid and leucotylic acid as major constituents, whereas *M. metarevoluta* contains galbinic acid and leucotylin. At present *M. salazinica* is known from several locations in Yunnan Province, southwest of China, whereas *M. metarevoluta* is more widely distributed in the eastern United States, Japan and China (Anhui, Hubei, Zhejiang Provinces) (Wei 1991, Zhao 1964).

Paratype Specimens Examined

CHINA. Yunnan, Mt. Gongshan, Cikanpuladadui, 3200 m, on bark, *J. J. Su, 2543,* 25 July 1982 (HMAS-L); Mt. Gongshan, Buquanwa, 1400 m, on bark, *J. J. Su, 3126,* 22 Aug. 1982 (HMAS-L); Yingjiang County, Tongbiguan, 1200 m, on bark, *J. J. Su, 3083,* 20 June 1981 (HMAS-L).

Myelochroa sinica S. L. Wang, J. B. Chen & Elix, sp. nov. Fig. 2

Thallus ut in *Myelochroa xantholepis* sed lobis elobulatis et angustioribus differt.

Type: CHINA. Yunnan: Zhongdian County, Xiaozhongdian Linchang, 3600 m, on rock, *X. Y. Wang, X. Xiao & /J. J. Su 5642,* 22 Aug. 1981; (holotype: HMAS-L; isotype: CANB).

Thallus saxicolous, small foliose, adanate, 1.5-2.5 cm wide. *Lobes* densely imbricate, sublinear to subirregular, irregularly branched, apically subrotound, 0.5-1.2 mm wide; the margin ciliate, cilia simple, sparse.

Upper surface pale mineral grey, flat, shiny, emaculate, with blackened margins, lacking isidia, soredia and lobules. *Medulla* sulfur yellow. *Lower surface* black; rhizines moderately dense, black, simple. *Apothecia* not seen. *Pycnidia* immersed; conidia bacilliform or weakly bifusiform, 4.5-6.5 x 1 μ m.

Chemistry. Cortex K+ yellow; medulla more intensive yellow with K, C, P; containing atranorin (major), chloroatranorin (trace), secalonic acid A (minor), secalonic acid C (minor), xantholepis pigments (minor), 16b-acetoxyhopane-6a,22-diol (minor), 6a-acetoxyhopane-16b,22-diol (minor), leucotylin (minor).

Chemically this new species is identical with *Myelochroa xantholepis* (Mont. & v. d. Bosch) Elix & Hale but it differs morphologically in having much smaller (1.5-2.5 cm *cf.* 4-15 cm wide), coriaceous thalli, narrow lobes (0.5-1.2 mm *cf.* 1-5 mm wide) with an emaculate, elobulate upper surface. By contrast, the large thalli of *Myelochroa xantholepis* are extremely fragile and develop numerous, imbricate lobulae in the centre of the thallus and along the margins and have a maculate upper surface. *Myelochroa crenualta* also appears related to these two species. However, like *M. xantholepis* it has a lobulate upper surface and broad lobes, 1.5-3.0 mm wide.

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TRICHARINA STRIISPORA FROM ARGENTINA AND THE FINDING OF ITS ANAMORPH, ASCORHIZOCTONIA

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Abstract. For first time the anamorph of *Tricharina striispora* was obtained in culture from germinated ascospores and was placed in the genus *Ascorhizoctonia (Mycelia sterilia).* Macro-micromorphological characters are described, using light and electron microscopy.

Keywords: Pezizales, teleomorph-anamorph connection, Scanning and Transmission Microscopy.

The genus *Tricharina* was coined by Eckblad (1968) to replace *Tricharia* Boud. (1885) which is illegitimate as a later homonym of *Tricharia* Fée 1824, a lichenised fungi (Santesson 1952). This genus is close to *Trichophaea* Boud. but it is readily separable on the lack of oil drops and on the type of anamorph produced, being *Dichobotrys* Hennebert for *Trichophaea* species (Hennebert, 1973) and *Ascorhizoctonia* for *Tricharina* species (Yang & Korf, 1985 a).

Yang and Korf (1985 b) in their monograph of *Tricharina,* concluded to split it into two genera: *Tricharina sensu stricto* and *Wilcoxina* Chin S. Yang & Korf based on apothecial structure, on germination of ascospores, on type of anamorph and on mode of nutrition.

During a survey of species belonging to the Pezizales in the Central East of Argentina an interesting collection belonging to *Tricharina* was found with longitudinal striate ornamentation of the ascospore wall. According to Yang and Korf (1985 b) this kind of ornamentation is only found in one species of the genus: *Tricharina striispora* Rifai, Chin S. Yang & Korf. This species was originally described from Australia (Yang & Korf, 1985 b), on the basis of a material collected in 1920 by J. Cleland and first examined by Rifai, though not published.

The objective of this paper is to describe for the first time the anamorph, the *Ascorhizoctonia* state of *Tricharina striispora*, to present the results of the germination of the ascospores and the preliminary studies of the ascospores with Scanning and Transmission Electron Microscopy (SEM and TEM).

Materials and Methods:

Fresh collections of apothecia found on decayed wood and soil, were examined in the field, where taking data about substrate, size and color of the ascomata were also taken. The specimens and living culture were deposited at BAFC Herbarium and BAFC culture collections respectively (Holmgren *et al.*, 1990). Parts of the BAFC collections were also kept at CUP and living cultures at CUP and MUCL.

At the laboratory micromorphological observations were made mounting sections of portions of the apothecium in phloxine or lactophenol plus cotton blue for examination in light microscopy.

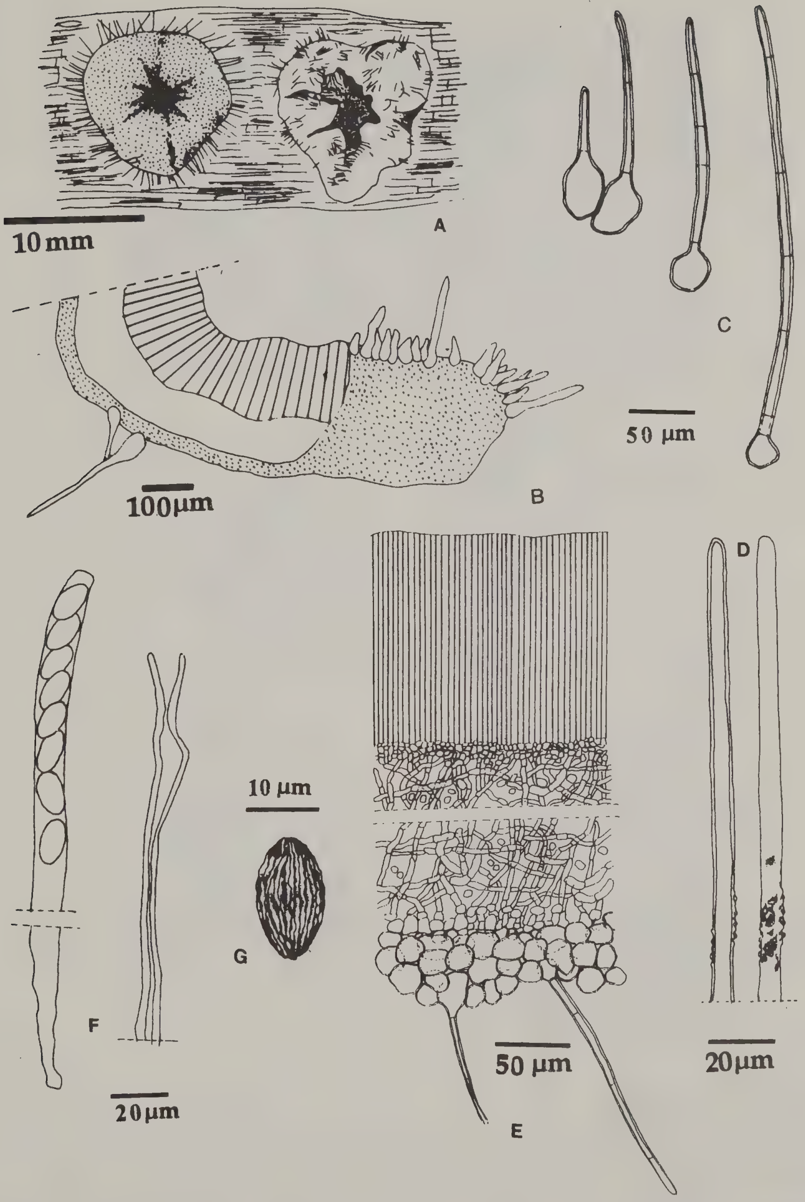
For observations in SEM a small portion of an apothecium was separated with dissecting needles and dehydrated in alcohol 30 %.

For ultrastructural examination the applied techniques are according to Samuelson (1978) except for some modifications: one millimetre squares of apothecia were used and fixed in Millonig's buffer (Millonig, 1961) and 3% glutaraldehyde for 24 hs, postfixed in 1% osmium tetroxide for 2 hs; dehydration in alcohol series and the final rinse with acetone; embedded in Spurr resin.

Isolations were made from ascospores obtained by stimulating the "puffing" from an apothecium placed in the cover of an inverted petri dish containing water agar with streptomicin so the hymenium faced the agar surface, illuminating it as explained by Donadini (1984). Once the ascospores germinated, they were transferred onto MA, OA plates (Hawksworth *et al.* 1995) and CM (M-5 Stevens, 1974), and kept at room temperature (23°C).

Tricharina striispora Rifai, Chin S. Yang & Korf. Mycotaxon 24: 509. 1985. (Figs. 1 and 2, Pl. I)

Apothecia small, discoid, sessile, 0,5-1,7 cm diam., fleshy when fresh; hymenium creamy white, externally with brown hairs; marginal hairs simple, septate, with bulbous base, 200-350 µm long, 5-6 µm diam at apex and 10-15 µm at base, walls thick, smooth or ornamented with warts; cortical excipulum "textura globulosa", 25-40 µm thick, 17-30 µm diam cells; medullary excipulum "textura intricata", 75-120 µm thick; asci cylindrical, 8-spored, inamiloid, 175-185 x 9-12 µm; ascospores 1-celled, ellipsoid, longitudinally striate, with warts over the striae, 15-18 x 8-9 µm; paraphyses filiform, flexuous, simple, septate, 2-3 µm broad, enlarged near apex to 4-5 µm. **Habitat:** On decayed wood; on soil beneath a fallen trunk.



10 mm
A
C
50 µm
100µm
B
D
F
10 µm
G
50 µm
20µm
20µm
E

Fig. 1. *Tricharina striispora* Rifai, Yang & Korf. A, apothecia; B, longitudinal section; C, hairs with bulbous base; D, detail of apical portion of hairs; E, details of excipulum; F, asci and paraphyses; G, ascospore. (BAFC 34500, mounted in phloxine)

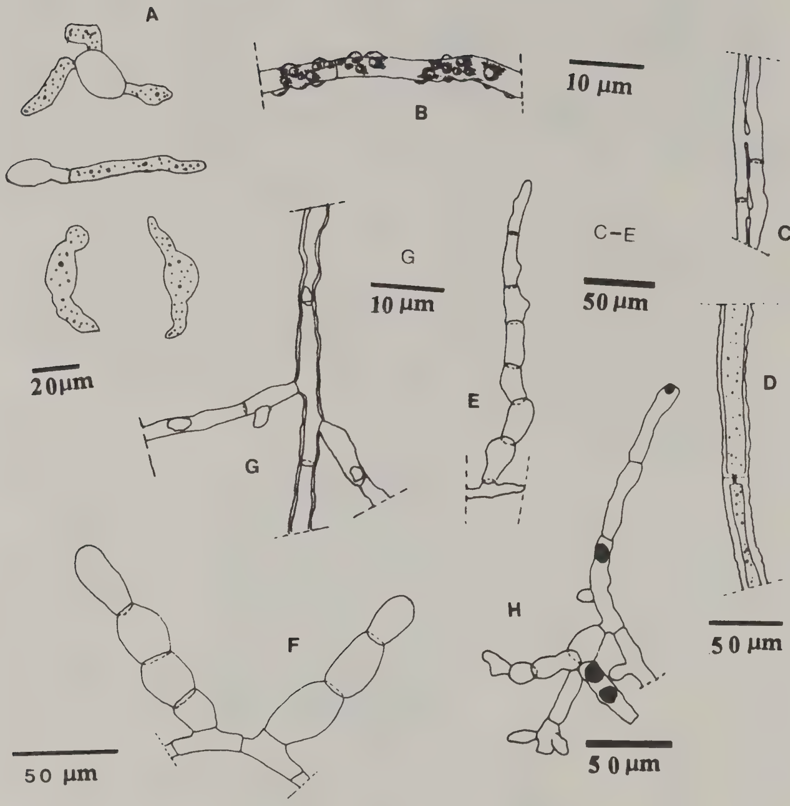
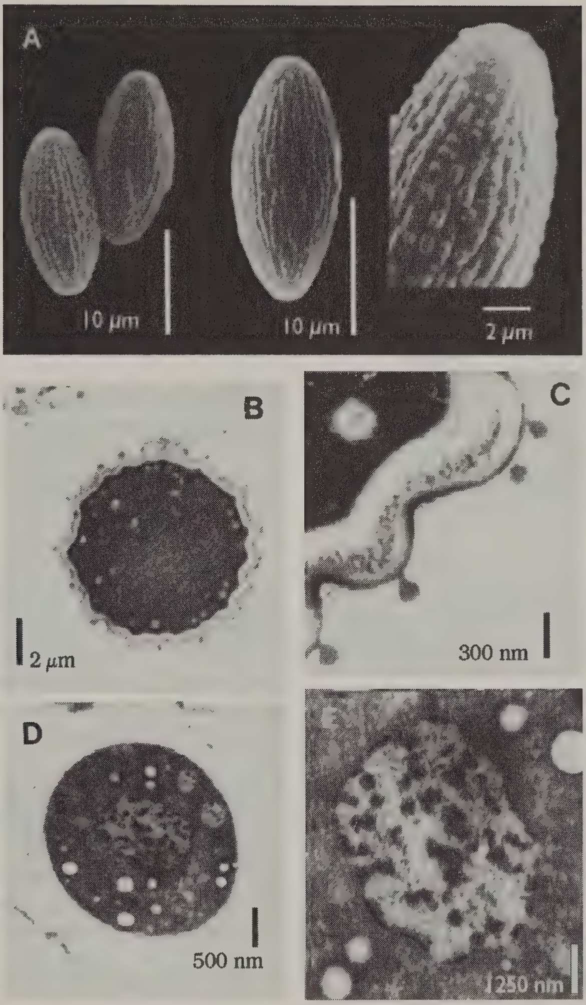


Fig. 2. *Tricharina striispora* Rifai, Yang & Korf. A, germinated ascospores in ME; B, detail of hyphal ornamentation; C, hyphal fusions; D, hyphal septum; E and F, monilioid cells; G and H, mycelium growing in ME. (BAFC cult. 202, mounted in cotton blue.)

Anamorph: *Ascorhizoctonia-state*: Colonies slow-growing, covering 90 mm petri plates in 10 days on ME at room temperature (23°C), forming concentric inconspicuous bands in ME. Mycelium superficial and colorless, becoming immersed and dark brown at maturity, aerial hyphae also dark brown at maturity. Hyphae cylindrical, 6,5-8 µm diam, brownish, smooth or densely incrusted, sometimes constricted at septum. Hyphae can be parallel and anastomosing forming bridges; others branch at acute angles, with hyphal loops formed by coiling. Monilioid cells aggregated, 14-19-(21-24) x (17-23)-30-32 µm, formed in


A
10 μm
10 μm
2 μm
B
2 μm
C
300 nm
D
500 nm
E
250 nm

Pl. I. *Tricharina striispora* Rifai, Yang & Korf. A, ascospores in SEM; B-E, ascospores in TEM; B, transversal section of an ascospore; C, ascospore wall in detail; D, young ascospore in transversal section; E, nuclei of an ascospore. (BAFC 34500) the agar and on the aerial hyphae, cells containing abundant oil guttules.

Yang & Korf (1985) place *Ascorhizoctonia* in Mycelia Sterilia.

Studied materials: Argentina, Buenos Aires, Lomas de Zamora, Santa Catalina, leg. Romero *et* Barrera, 10-V-1996, on fallen bark and decayed wood, BAFC 34500 (part of this collection CUP 63644); idem, 4-V-97, on soil, BAFC 34916; idem, IV-1997, BAFC cult. 202. An isolation from BAFC 34500 is deposited at MUCL 41297.

Notes:

The ascospores germinated with up to three germ tubes after 48 hs resting on water agar with streptomicin.

Under light microscopy is hard to observe the longitudinal striae, but in the SEM (Pl. I, A) they were confirmed and some pedicellate warts were observed on them. TEM was used to check this structure (Pl. I, B-E). Ascospores in transverse section showed that warts consist of a dense corpuscule attached by a pedicele to the ascospore wall (Pl. I, C). Probably its origin is the external layer of the ascospore wall.

Discussion:

Hennebert (1973) erected the generic name *Dichobotrys* for the anamorphic states previously recognized for *Trichophaea* species. Yang & Korf (1985 a) have proposed *Ascorhizoctonia* for the anamorphic state of *Tricharina*. Until the work mentioned above the only character for separating *Tricharina* from *Trichophaea* was the presence of guttules in the ascospores of the latter, but the difference between the correlated anamorphs clearly helps to distinguish the two genera.

There were two collections of *Trichophaea* cited for Argentina by Gamundí: *Trichophaea fimbriata* (Quél.) Gamundí (1966) and *T. eguttulispora* Gamundí (1975) (Holotypus! LPS 36891, LPS 36889, LPS 36901). The former was transfered to *Tricharina gilva* (Boud. in Cke.) Eckblad by Yang and Korf (1985 b), and the latter was also transfered to *Trichophaeopsis bicuspis* (Boud.) Korf and Erb subsp. *eguttulispora* (Gamundí) Korf (1977).

So far *T. gilva*, from Tierra del Fuego (Gamundí 1975) and, *T. striispora* from Buenos Aires province, are the only two species of this genus present in Argentina.

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ON THE PRESENCE OF RUSSULA LACCATA IN SIERRA NEVADA (ANDALUCIA, SOUTHERN SPAIN) AND ITS TAXONOMIC RELATIONSHIPS WITH R. NORVEGICA

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Abstract. Based on abundant material collected in Sierra Nevada (Andalucia, Spain) and the study of type material, the authors conclude that *Russula laccata* Huijsman and *R. norvegica* Reid belong to the same species. Taxonomic comments about the variability of some characters are made. Microphotographs made under the S.E.M. of the spores of both taxa are given for comparison.

Resumen. Un estudio comparativo basado en numerosas colecciones procedentes de Sierra Nevada (Andalucia, España), nos ha permitido concluir que *Russula laccata* Huijsman y *R. norvegica* Reid son co-específicas. Se realizan comentarios taxonómicos sobre la variabilidad de ciertos caracteres. Se llevó a cabo un estudio comparativo del material tipo de ambos táxones, y se aportan fotografías realizadas al microscopio electrónico de barrido.

Keywords. Systematics, *Russula laccata*, *Russula norvegica*, *Salix*, Sierra Nevada, Spain

Introduction

Since 1995, and practically every following year, we have collected in Sierra Nevada (Granada, Andalucia), in riparian montane forests with *Salix atrocinerea* Brot. and *S. neotricha* Goerz, a small *Russula* which was first identified as *R. atrorubens* Quél. *s.* J.E. Lange. In his recent *Russula* monograph, SARNARI (1998) considers that the correct name of this taxon is *R. laccata* Huijsman. Since the Italian author has accepted *R. norvegica* D.A. Reid as conspecific, this last traditionally recognized as a strictly boreo-alpine taxon, we have carried out a comparative study between the collections from Sierra Nevada and the type material of both *R. laccata* and *R. norvegica.*

Next, a brief description of the macro and micromorphological characters of the material collected in Sierra Nevada is given. The microscopic features also include those observed in both type materials. Comments on the Iberian distribution based on bibliographic information of both taxa are also given.

The Spanish collections have been deposited in (GDAC) and (AH), Herbarium of Granada University and Herbarium of Alcala University respectively. The holotypes of both, *R. laccata* and *R. norvegica* were sent on loan from (L) and (K). The methods followed have been those traditional in *Russula* studies, and general bibliography on this genus consulted has been that of ROMAGNESI (1967), BON (1988), KNUDSEN & STORDAL (1992), REUMAUX *et al.* (1996) and SARNARI (1998).

Brief description

Russula laccata Huijsman, Fungus 25: 40 (1955)
= *Russula norvegica* D.A. Reid, Fung. Rar. Icon. Color. 6: 36 (1972)
= s *Russula atrorubens* Quél. *s.* J.E. Lange, Fl. Agar. Dan. : 63 (1940) - *pro parte-*

Selected descriptions: Huijsman (*loc. cit.*: 40-42); Reid (*loc. cit.*: 36-37) -as *R. norvegica-*; Kühner (1975) -as *R. norvegica* and *R. norvegica* var. *rubromarginata*; Gulden et al. (1985: 49-50) -as *R. norvegica-*; Llistosella (1998: 84) -as *R. norvegica-*; Sarnari (*loc. cit.*: 520,522).

Selected icones: Reid (*loc. cit.*: pl. 48b) -as *R. norvegica-*; Phillips (1981: 101) -as *R. norvegica-*; Gulden et al. (*loc. cit.*: 49-50) -as *R. norvegica-*; Ballarà (Bolets de Catalunya XII: làm. 844, 1998) -as *R. norvegica-*; Sarnari (*loc. cit.*: 519,523 and 525).

Material studied. SPAIN: Andalucía, Granada, Sierra Nevada, Aldeire, 1370 m, under *Salix* and *Populus*, 15-XI-1995, *A. Capilla*, GDAC 44493. Sierra Nevada, Huéneja, 1200 m, under *Salix*, 12-XI-1998, *A. Capilla*, GDAC 44495. *Ibidem*, 1220 m, 22-XI-1998, GDAC 44496. Sierra Nevada, Lanteira, 1380 m, under *Salix*, 12-X-1996, *A. Capilla*, GDAC 44494. *Ibidem*, 13-XI-1999, *A. Capilla, F. Esteve-Raventós & A. Ortega*, AH 25297. Sierra Nevada, Jeres del Marquesado, 1290 m, under *Salix*, 10-X-1999, *A. Capilla*, GDAC 44497. **THE NETHERLANDS**: Gelderland, Winterswijk, Korenburger Veen., 28-X-1952, *H.S.C. Huijsman*, L (holotype of *Russula laccata* Huijsman). **NORWAY**: Dalsnibba, Mt. Geirander, 29-VIII-1969, *D.A., D.G. & P.M. Reid*, (K) -KCM/62124 (holotype of *Russula norvegica* Reid).

Pileus 15-50 mm in diam, plano-convex, becoming depressed at the centre; margin smooth or usually sulcate-tuberculate in old specimens; cuticle almost entirely separable, finely tomentose (under the lens) but usually brilliant and smooth when humid; color very variable, from uniformly dark purple, sometimes with nearly black disc, but ranging to reddish purple, usually mixed with violaceous and/or greenish tones. Lamellae subdistant, white, slightly yellowing with age or when dry. Stipe 30-50 x 8-15 mm, sometimes hard and solid, but usually very fragile (if soaked in very wet substrate), cylindrical to clavate, usually purely white, ocassionally exhibiting pinkish tints, often ochraceous spotted at the base. Flesh white, smell reminiscent of coconut or fruity. Taste strongly acrid. Spore-powder white to pallid cream (I a-b, of Romagnesi's code). Spores 7-10(-11.5) x 5-7(-8) µm (Xm = 7.6-8.4 x 5.6-6.5 µm), ellipsoid to broadly ellipsoid, ocassionally ovoid (Q: L/l = 1.2-1.6; Qm = 1.35), ornamented with pyramidal warts, occasionaly isolated, by frequently more or less interconnected by thin crests, sometimes even subreticulate or, in some cases, even forming a complete reticulum (Fig. 1), strongly amyloid; spore plage slightly amyloid. Pileipellis made up of interwoven hyphal terminations, the terminal cell cylindrical to subclavate, 1.5-3.5 µ wide; dermatocystidia (SV +), very abundant, cylindrical to clavate, 6-10 µm wide, with variable number of septa (0-3), frequently one septate. Pleuro and cheilocystidia numerous, cylindrical to fusiform, 50-65 x 5.5-12 µm. Basidia 4-spored, clavate.

Comments

Since it was first described by Huijsman, *R. laccata* has been a long forgotten species until Sarnari has reevaluated its taxonomic position after the revision of the type material; the Italian mycologist has resurrected this name, and demonstrated that *R. laccata* is contaxic with *R. atrorubens* Quél. *s.* J.E. Lange, at least in part. Only ROMAGNESI (*loc. cit.*: 507) describes *R. laccata* shortly, based on authentic material sent to him by Huijsman, which the French author considers a form of *R. olivaceoviolascens* Gillet.

Some of the descriptions of *R. atrorubens* in the European literature (e.g. EINHELLINGER, 1976; BABOS, 1987) refer to a small taxon which grows in very humid ecosystems, where the presence of *Salix spp.* is constant, sometimes mixed with *Betula*, *Populus* or *Alnus*, but never with conifer trees. SARNARI´s (*loc. cit.*) interpretation of *R. atrorubens* Quél. refers to another species that grows in montane to subalpine conifer forests, which is characterized by the stouter habit, more reddish-carmine pileus color and a smell of amyl acetate. This same taxon was described recently by LLISTOSELLA (1998) from Andorra in subalpine *Pinus uncinata* forests with *Betula pendula*. In fact, *R. laccata* and *R. atrorubens* (= *R. olivaceoviolascens* Gillet *s.* Romagn ?) seem to differ basically in size, habitat and some cromatic and organoleptic aspects (some of these characters, however, very variable in *Russula spp.*). Some authors (e.g. LANGE, *loc. cit.*; ROMAGNESI, *loc. cit.*; MARCHAND, 1977) point out that *R. atrorubens* can be found either in conifer or broadleaved forests. If further studies would demonstrate the conspeficity of *R. olivaceoviolascens* Gillet with *R. atrorubens* Quél., the first epithet should have nomenclatorial priority.

The material of *R. laccata* gathered in Sierra Nevada is characterized by its high variability in some morphological aspects. The pileus size ranges from very small to relatively large (15-50 mm), the colours range from dark purplish to dark reddish, sometimes mixed with greenish or violet tones [hence reminding those of *R. fragilis* (Pers.: Fr.) Fr.], and the spore print is white (I a-b) to pale cream (II a) in the code of ROMAGNESI (*loc. cit.*). The flesh consistency in the specimens studied from Sierra Nevada is normally brittle, but in some collections hard, though fragile, but it seems that water amount of the substrate and age of the basidiomata exert a high influence on this character. Microscopically, the spores show a variable ornamentation within a single specimen, obviously depending on the degree of ripening; all of them show prominent subacute to obtuse pyramidal warts with strong amyloid reaction, which are usually interconnected by thin, more or less complete transverse lines; these lines sometimes form a nearly complete or totally complete reticulum, but in other cases they

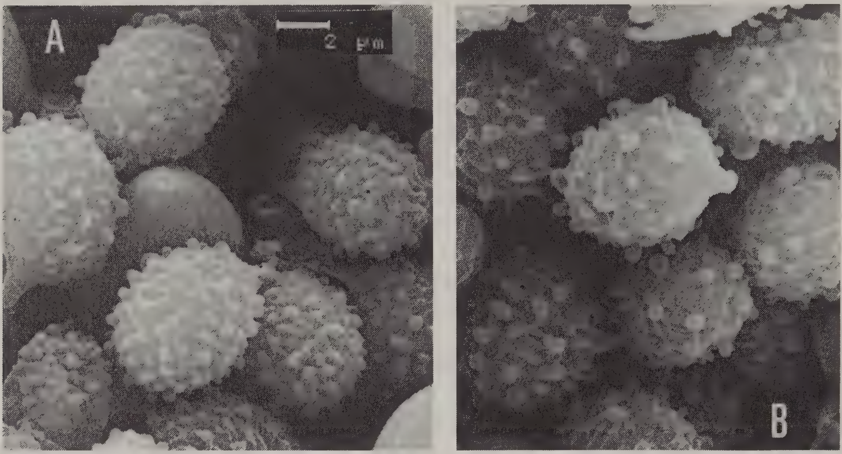

Fig. 1.- A, spores under the S.E.M. of *Russula laccata* (GDAC 44495). B, spores under the S.E.M. of *R. laccata* (GDAC 44496).

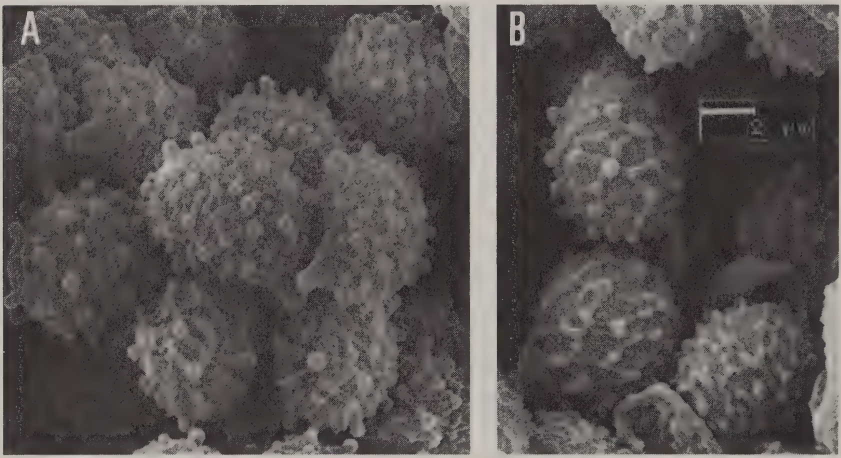

Fig. 2.- A, spores under S.E.M. of *R. laccata* (Holotypus, L). B, spores of *R. norvegica* (Holotypus, K).

show a more or less cristulate pattern. Both types of spore ornamentation have also been observed in both holotypes studied by us (Fig. 2), as well as the spore size which turned out to be overlapping [7.5-9.5(10) x 5-7(-8) µm, Xm = 8.6 x 6.3 µm, Q: L/L = 1.2-1.5, Qm = 1.36 for *R. laccata*; 7.5-9(9.5) x 5.2-7.2 µm, Xm = 8.5 x 6 µm, Q: L/l = 1.2-1.6, Qm = 1.4 for *R. norvegica*]. Lastly, the number of septa of the dermatocystidia of all the studied material ranges from 0-3, though 1 is most frequent.

SARNARI (*loc. cit.*) has considered *R. norvegica* a synonym of *R. laccata*, based on his own material and the numerous descriptions of Reid's taxon, but without having revised the type material. This synonym might, at first view, seem surprising, as *R. norvegica* is a very well known taxon, widespread in alpine-subalpine and arctic-subarctic habitats in Europe (KÜHNER, 1975; GULDEN & al., *loc. cit.*; BON, *loc. cit.*; SENN-IRLET, 1987; JAMONI, 1989; FELLNER & LANDA, 1993; KNUDSEN & MUKHIN, 1998, etc.). BRESINSKY (1987) and KNUDSEN & STORDAL (*loc. cit.*) have also commented on its presence in temperate dune areas with *Salix repens* in Sylt Island (Germany) and Scandinavia respectively, which are very interesting ecological data.

In the Iberian Peninsula, *R. norvegica* has also been registered in the Eastern Pyrenees of Catalonia and Andorra (LLISTOSELLA, 1991; BON & BALLARÀ, 1995; VILA et al., 1997, 1998), always in snow beds in the alpine level with *Salix herbacea* and/or *S. retusa*, on acid soils.

The revision of the type material of *R. norvegica* has not revealed significative differences with respect to *R. laccata*. The material from Sierra Nevada, found in riparian very humid ecosystems with *Salix atrocinerea* and/or *S. neotricha*, could either be adscribed to *R. laccata* or *R. norvegica* (with the exception of the habitat), and we conclude that *R. norvegica* can merely represent a boreo-alpine variant or ecotype of *R. laccata*. Consequently, Sarnari's consideration is supported with our observations.

According to BON (*in litt.*), *R. laccata* and *R. norvegica* represent two different species, and would differ basically by the size and colour of the pileus (darker in *R. laccata*), spore-print colour (cream versus white), spore size (7-8.5 x 6-7 µm in *R. laccata*; 7-9 x 6-7.5 µm in *R. norvegica*), and habitat. However, these differences pointed out by Bon, cannot be supported after the study of both holotypes and the Sierra Nevada collections. The large amount of specimens studied have revealed that a broader variation of the morphological characters which have been traditionally recognized for both taxa exists. We do not consider necessary to recognize two different varietal taxa of *R. laccata*, though an arctic-alpine variant (*R. norvegica*) might be admitted.

Acknowledgements

We wish to express our sincere gratitude to Dr. M. Bon (St. Valery-sûr-Somme, France) for his comments. Dr. J. Llistosella (Departamento de Biologia Vegetal, Universidad de Barcelona) is thanked for revising and improving the original draft. To the curators of the Herbaria of the Royal Botanic Garden at Kew, England (K), and Rijksherbarium, Leiden, The Nertherlands (L), for the loan of type material. To A. Capilla for his unvaluable help in the field research. To Drs. J.B. Bueno and A. González for their assistance in the S.E.M. study. Finally, to the D.G.I.C.Y.T. (Dirección General de Investigación Científica y Técnica, Ministerio de Educación y Cultura), for the financing of the Research Project PB98-1316.

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MYCOTAXON

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AMANITA BASIANA—A NEW SPECIES FROM PURE PINUS FOREST AND RESEMBLING THE ALNUS-ASSOCIATED SPECIES AMANITA FRIABILIS

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Summary

Amanita basiana (*Amanita* section *Amanita*) is described as new from pure pine forest in Liguria, Italy. It is phenetically similar to *A. friabilis*, which is only known from wet habitat associated with *Alnus*.

Riassunto

Amanita basiana (*Amanita* sezione *Amanita*) viene descritta come una nuova specie rinvenuta in pineta pura in Liguria, Italia. Essa é morfologicamente simile ad *A. friabilis*, conosciuta solamente crescita in habitat umido e in associazione con *Alnus*.

Methods and terminology in the present paper are based on those of Tulloss *et al.* (1992) with amendations from Tulloss (1993, 1994) that have been summarized in (Tulloss, 2000). Abbreviations for names of herbaria are derived from Holmgren *et al.* (1990). Color notations of the form "5E5" are from Kornerup and Wanscher (1978).

AMANITA BASIANA Tulloss & M. Traverso *sp. nov.*

Illus.: Tulloss & M. Traverso. 2000. *Boll. Gruppo Micol. G. Bresadola* 43(2): figs. a-d.

Pileus (30-) 40 - 75 (-100) *mm latus, initio pallidocinereus vel brunneogriseus deinde griseobrunneus vel flavobrunneus vel brunneus, saepe disco fusciore, raro omnino fuligineus, initio globosus deinde plano-convexus, haud umbonatus, solito siccus, caelo humido tamen viscidus, nunquam glutinosus, rare nudus etsi imber effusus est assiduus; margine striato* (0.3R - 0.5R) *non appendiculato; carne alba non mutabili; laminis farinosis vel coactis vel subcoactis obtectus, plus minusve latis, atque verrucis exiguis densisque, initio albis dein griseis denique brunneolis, ad pileipellem adnatis veli universalis vestigiis. Lamellae liberae vel uncinatae, albae, subdistantes,* 8 - 9 *mm latae, lamellulis truncatis vulgaribus longitudine varia. Stipes* ($10^{\pm}$-) 35 - 90 (-110) × 10 - 13 (-20) *mm, albus, materia flocossa et cinerea vela universalis decoratus, bulbo basali, annulo evanescente, saepe fragmento subbasali annuliformi vela universalis, saepe zona subbasali strangulata et non decorata. Sporae* (8.5-) 10.0 - 13.6 (-26) × (7.5-) 8.0 - 10.7 (-15.3) *μm, subglobosae vel late ellipsoideae vel ellipsoideae, raro cylindricae. Basidia* 35 - 64 × 12.7 - 17.1 *μm, plurima tetrasporigera, alia bisporigera. Fibulae nullae. Holotypus: in loco Piani di Prá, Janua Ligurum, Italia*, 26.x.1999 M. Traverso & P. Roncallo [Traverso 30.0] (GDOR).

Etymology: In honor of Dr. Cornelis Bas, Rijksherbarium, Leiden, perceptive, meticulous, and innovative monographer of *Amanita*, *Squamanita*, *Pseudobaeospora*, etc.; dedicated and demanding editor of *Persoonia* and *Flora Agaricina Neerlandica*; Pied Piper of mycology in the Netherlands; academic parent of a generation of finely trained agaricologists; generous friend and mentor.

PILEUS: (30-) 40 - 75 (-100) mm wide, pale ash gray to brownish gray at first, becoming darker with age such as brownish gray with bronze tint or yellowish brown or brown (*e.g.*, 5E5 or 6E4), usually darker over disc, rarely entirely fuligineous, globose at first, then hemispheric, finally convex to plano-convex, not umbonate, slightly viscid in humid weather but not sticky; *context* white, unchanging when cut or bruised, 6 - 8 mm thick over stipe; thinning evenly to $75^{\pm}\%$ of radius then membranous to margin; *margin* striate (0.3R - 0.5R), nonappendiculate; *universal veil* as broad felted patches or confluent warts, whitish in button stage then grayish and finally brownish, friable, difficult to remove entirely even after heavy rains, often eventually detersile in age.

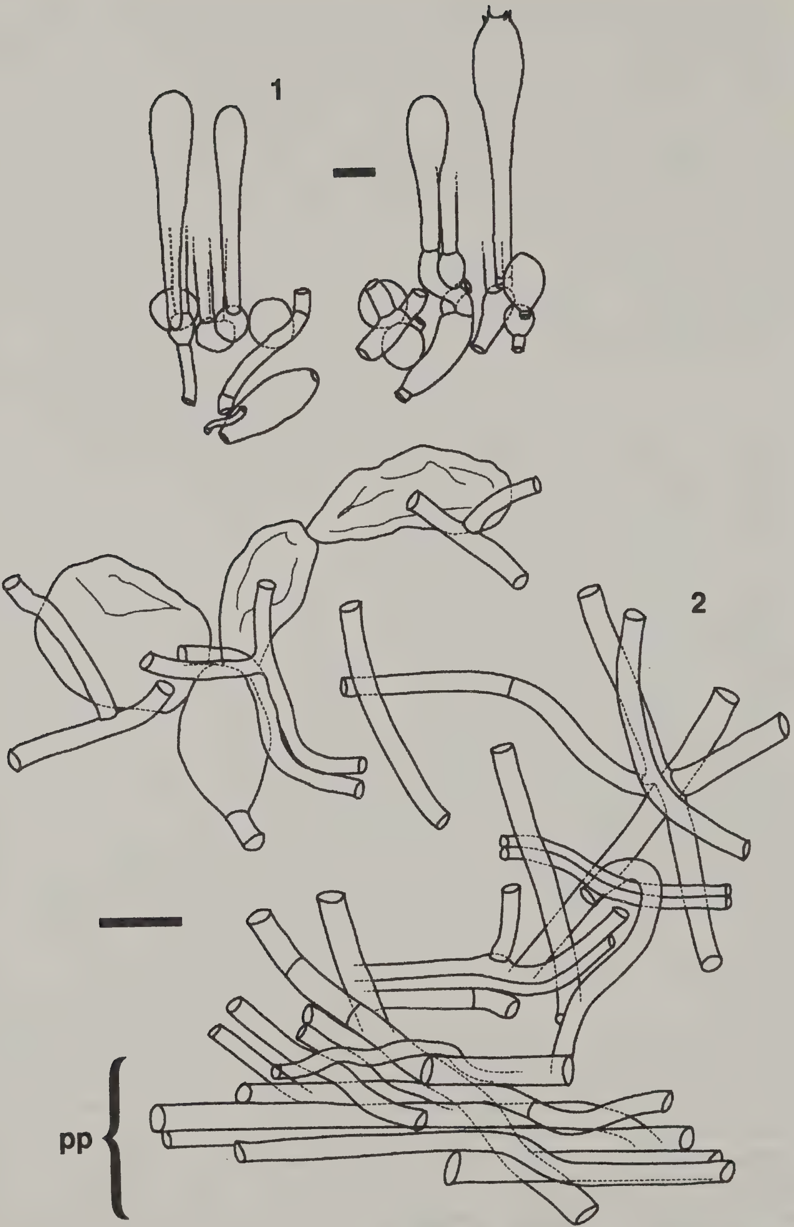
LAMELLAE: usually free, briefly uncinate in some basidiocarps, with short decurrent lines on stipe apex, subdistant, 1.5 - 2 mm apart at pileus margin at maturity, white to cream-white, 8 - 9 mm broad, neither forking nor anastomosing, with finely floccose edge concolorous with or slightly darker than hymenial surface; *lamellulae* truncate, of diverse lengths (from 0.3 – 0.8× length of lamellae), irregularly distributed, common.

STIPE: ($10^{\pm}$-) 35 - 90 (-110) × 10 - 13 (-20) mm, cylindric or narrowing upward slightly, flaring very slightly at apex, with fine pale brownish gray squamules on upper part, decorated with blackish brown somewhat subtle zebrature becoming denser and coarser toward stipe base or when interrupted in this region forming obliquely oriented rings (see below); *bulb* subovoid, $20^{\pm}$ × 10 - 20 (-25) mm, sometimes very minimal in mature material; *context* white, unchanging when cut or bruised, often with brown-orange or ferruginous spots in base of bulb, stuffed with pithy material at first, then hollow, with central cylinder 3 - 5 mm wide; *partial veil* as very thin membrane clearly visible in partially expanded button specimens, whitish, often evanescent and quickly lost; *universal veil* as friable layer on upper part of bulb, sometimes lost at least in part, concolorous with material on pileus, sometimes with incomplete cottony ring of *limbus internus* on lower stipe suggesting inferior to subbasal annulus.

Odor not distinctive. *Taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 60 - 170 µm thick, with colorless upper layer 25 - 55 µm thick and brown-orange lower layer 35 - 120 µm thick, often ungelatinized below warts or patches of universal veil but becoming partially gelatinized in colorless layer in age, with occasional openings allowing view of lower layers of pileipellis hyphae, with broken stubs of filamentous, undifferentiated hyphae (common) and vascular hyphae (infrequent) scattered over surface (apparently remnants of hyphae formerly crossing boundary between pileipellis and universal veil); filamentous, undifferentiated hyphae 2.3 - 7.6 µm wide, branching, in fascicles, dominantly radially arranged except over disc, there less tightly packed and interwoven, minimally gelatinized even in areas lacking universal veil (in Traverso 30.2); vascular hyphae 3.8 - 11.4 µm wide, sinuous, rarely branching, scattered, but locally common and somewhat mutually interwoven. PILEUS CONTEXT: filamentous, undifferentiated hyphae 2.2 - 8.9 μm wide, common, commonly branched, comprising open lattice structure, infrequently with yellowish subrefractive walls, with plentiful intercalary inflated cells up to 159 × 38 μm (sometimes in short chains, subfusiform to fusiform to broadly fusiform, thin-walled); acrophysalides up to 89 × 39 μm, often with inflated subtending hyphal segment, clavate to elongate-ellipsoid, common, thin-walled; vascular hyphae 3.8 - 15.0 μm wide, uncommon, sinuous, infrequently with tight loop or self-entangled. LAMELLA TRAMA: bilateral; w_{cs} = 55 - 60 μm (moderate rehydration); subhymenial base dominated by diverging inflated to partially inflated hyphal segments, usually one or two such segments sufficient to connect central stratum to subhymenium; filamentous, undifferentiated hyphae 2.5 - 3.6 μm wide with frequent slightly inflated intercalary segments up to 13.0 μm wide and in both central stratum and subhymenial base; terminal, inflated cells not observed; vascular hyphae 3.0 - 5.5 μm wide, scattered, tangled locally, sinuous, branching very infrequently. SUBHYMENIUM: w_{st}-near = 70 - 75 μm (moderate rehydration); w_{st}-far = 85 - 90 μm (moderate rehydration); [w_{st}-far - w_{st}-near] = 15 - 40? μm; having frequently branching short-segmented structure with segments variously uninflated, partially inflated or fully inflated, with inflated cells usually having major diameter less than 12.5 μm, with basidia arising from segments of any of these types. BASIDIA: 35 - 69 × 12.7 - 17.1 μm, 4- or infrequently 2-sterigmate, with sterigmata up to 10.0 × 2.8 μm; clamps not observed here or in any other tissue. UNIVERSAL VEIL: *On pileus, away from pileus surface*: filamentous, undifferentiated hyphae 2.1 - 7.1 μm wide, plentiful, branching, with walls thin or up to 0.5 μm thick, colorless or yellowish or brownish, sometimes with subrefractive walls, often slightly constricted at septa, often fasciculate; inflated cells plentiful, up to 74 × 57 μm, with walls thin or up to 0.5 μm (rarely to 0.8 μm) thick, colorless to brownish, globose to subglobose to subpyriform to ovoid to ellipsoid to broadly fusiform to clavate to narrowly clavate-constricted, terminal singly or more often in short chains of 2 - 4 (-6?) cells with distinct vertical orientation; vascular hyphae not observed. *On pileus, near pileipellis*: filamentous, undifferentiated hyphae more plentiful than in upper part, even dominating, many crossing between pileipellis and universal veil (Fig. 2); inflated cells scattered to fairly abundant, sometimes in clusters; vascular hyphae not observed. *From ring above strangulate region of stipe*: very similar to that on pileus, perhaps with inflated cells somewhat more plentiful; filamentous, undifferentiated hyphae 2.9 - 11.2 μm wide, plentiful to dominant, commonly branching, with walls thin or slightly thickened, sometimes with yellowish subrefractive walls, sometimes in fascicles; inflated cells up to 77 × 55 μm, plentiful, globose to subglobose to subpyriform to ovoid to ellipsoid to clavate (sometimes constricted), colorless or faintly brownish to faintly grayish to pale brown to pale yellow-brown, terminal in chains of up to six cells, with walls thin or up to 0.6 μm thick; vascular hyphae not observed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 4.2 - 10.3 μm wide, branching, plentiful, dominating near stipe surface; acrophysalides up to 300 × 40 μm (predominantly less than 230 μm long), sometimes subtended by similarly shaped inflated cell, dominating away from stipe surface; vascular hyphae 4.1 - 7.6 μm wide, sinuous, unbranching, infrequent, sometimes sublongitudinally oriented in narrow elongate coil. PARTIAL VEIL: *On upper stipe surface*: largely gelatinized; where remnants discernible, scattered clavate inflated cells of uniform proportions dominating, with all major axes longitudinally oriented, 28 - 65 × 15.0 – 23 μm, singly terminal on filamentous, undifferentiated hyphae. *From fresh material*: see (Tulloss & M. Traverso, 2000: fig. c).



Figs. 1-2. *Amanita basiana* (holotype). 1. Elements of hymenium and subhymenial tree. (Scale bar represents10 μm.) 2. Elements of lower part of universal veil and adjacent portion of pileipellis (pp), simplified by elimination of some hyphae. (Scale bar represents 20 μm.)

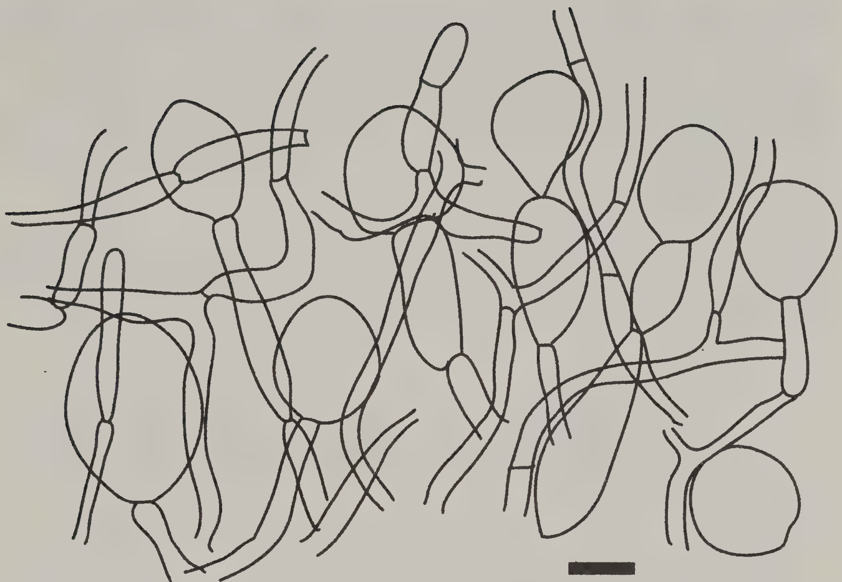


Fig. 3. *Amanita basiana* (2.xii.1997 Traverso *s.n.*) elements of universal veil from pileus in approximate radial section from region above contact with pileipellis, based on pencil drawing by Dr. C. Bas (original in L) annotated by him to indicate simplification by omission of numerous hyphae. (Scale bar represents 20 μm.)

BASIDIOSPORES: [280/14/3] (8.5-) 10.0 - 13.6 (-26) × (7.5-) 8.0 - 10.7 (-15.3) μm, (**L** = (9.7-) 11.2 - 12.1 (-13.2) μm; **L'** = 11.6 μm; **W** = (7.9-) 8.7 - 10.6 μm; **W'** = 9.2 μm; Q = (1.08-) 1.13 - 1.44 (-2.34); **Q** = 1.21 - 1.33 (-1.36); **Q'** = 1.27), hyaline, colorless, thin-walled, smooth, inamyloid, subglobose to broadly ellipsoid to (occasionally) ellipsoid, rarely elongate or cylindric (in such cases malformed), rarely constricted, often adaxially flattened, often swollen at one end, in immature material (especially) sometimes elongate-pyriform or peanut-shaped or subclavate or subfusiform or otherwise malformed; apiculus sublateral, cylindric; contents sometimes granular or multiguttulate but predominantly monoguttulate, often with additional small granules; white in deposit.

Habitat and distribution: Subgregarious to gregarious or in troops. Italy: At 230 - 250 m elev. In pure *Pinus pinaster* Ait. forest in dry area exposed to sunlight 50 m to 1 km from coast.

Collections examined: **ITALY**: LIGURIA - Genoa, Piani di Prà, 2.xii.1997 M. Traverso *s.n.* (L; RET; *in herb.* M. Traverso), 28.x.1998 M. Traverso 30.2 (NY; RET; *in herb.* M. Traverso), 26.x.1999 M. Traverso & P. Roncallo [Traverso 30.0] (holotype, GDOR; isotypes, L & RET & *in herb.* M. Traverso).

DISCUSSION

It was not possible to determine from macroscopic examination of exsiccata whether the tissue found on the stipe surface and ascribed to the partial veil was indeed part of a partial veil. However, partial veil tissue from fresh material depicted by Tulloss & M. Traverso (2000: fig. c) is very like the dried tissue we describe. This tissue is quite distinct from that of the universal veil because of the uniform form and orientation of the inflated cells as well as the fact that they do not occur in chains. Cells of this type (interspersed with similarly oriented hyphae and, often with a thin layer of similarly oriented hyphae on at least the upper surface) are typical of those found in partial veils in *Amanita*. Therefore, it seems probable to us that our description of the partial veil tissue based on dried material is correct, although possibly lacking some details.

Amanita basiana (Tulloss & M. Traverso, 2000: figs. a-b, d) seems, at first, strikingly similar to *A. friabilis* (P. Karst.) Bas, also known from Europe; however, there are a number of points distinguishing the two taxa:

- habit—The pileus of *A. friabilis* is (10-) 30 - 55 (-80) mm wide according to Bas (1974: 18).
- universal veil—That of *A. friabilis* has a greater percentage of inflated cells, especially away from the pileus surface (Bas, 1974: 19, fig. 5). This contributes to remnants of the universal veil on the pileus being segregated into distinct powdery warts.
- partial veil—If this structure is ever coherent in *A. friabilis*, it is much more tenuous than in the present species; indeed, Bas (1974: 21) considered *A. friabilis* to be a "ringless species."
- spore size and shape—The ranges of lengths and widths both are shifted upward slightly in the present species compared with the ranges in *A. friabilis* described by Bas (1974: 20 & 1982: 442). Our study of five collections of *A. friabilis* produced similar results (below). The range of **Q** is shifted downward in the present species compared with that range in *A. friabilis*. (The lowest **Q** value was obtained from data on spores of an old specimen that also exhibited the lowest value of **L**.)
- habitat—*A. friabilis* is only known to occur with *Alnus* in areas with wet soils while the present species is, to date, known only to occur with *Pinus* in a mesic region.

BASIDIOSPORES of *A. friabilis*: [100/5/4] (8.4-) 9.6 - 12.7 (-17.8) × (6.6-) 7.5 - 10.0 (-11.5) µm, (**L** = 10.8 - 11.9 µm; **L'** = 11.3 µm; **W** = 8.2 - 9.0 µm; **W'** = 8.5 µm; Q = (1.06-) 1.13 - 1.61 (-1.78); **Q** = 1.23 - 1.42; **Q'** = 1.33), hyaline, colorless, thin-walled, smooth, inamyloid, subglobose to broadly ellipsoid to ellipsoid, infrequently elongate, occasionally constricted, often adaxially flattened, often swollen at one end; apiculus sublateral, cylindric; contents sometimes granular or multiguttulate but predominantly monoguttulate, often with additional small granules; color in deposit not recorded.

Collections of A. friabilis examined: **AUSTRIA**: $5^{\pm}$ km SSE of Klagenfurth, Hauswandel, 7.x.1978 C. Bas 7422 (L; RET). **NORWAY**: HEDMARK - Rinsaker, Putten, Furnesåsen [$\mathrm{UTM}_{\mathrm{ED60}}$ (PN 10-11,53-54)], 22.ix.1995 G. Gulden 91/95 (O 70889). OPPLAND - Gjövik komm., Svennesvollene naturreservat [NN 8760 (1816 I)], 24.viii.1985 T. E. Brandrud & J. Stordal 24310 (O 58532). ÖSTFOLD - Hvaler, Kirköy, 2.ix.1982 Ö. Weholt 191182 (L; RET).

The poorly known *A. hyperborea* (P. Karst.) Fayod, originally described from "Russian

Lapland," has similarly shaped spores and an incompletely gelatinizing pileipellis. However, this species also has (Bas, 1982: 436-438)

- a basidiocarp that is almost entirely white or whitish
- spores with **Q** of 1.2—so far as is known (less than **Q** in any collection of *A. basiana* we have examined)
- hyphae in the universal veil on the pileus which commonly have refractive content
- an extreme northerly distribution—so far as is known.

Other taxa of *Amanita* section *Amanita* with

(a) pulverulent universal veil including hyphae intimately connected to pileipellis that is not or poorly gelatinizing

(b) partial veil lacking or ephemeral (with one apparent exception)

(c) basidia lacking basal clamps

(d) pileus and universal veil not brightly colored

(e) basidiocarp rather small and gracile with marked marginal striations on the pileus

differ from *A. basiana* as follows:

- *Amanita brunneoconulus* Bas & Gröger *in* Bas (1982) of Europe - stipe exannulate from early development; basidiocarp lacking any gray tones; universal veil on pileus disc disposed in conical warts; spores with **Q** = 1.05
- *Amanita farinosa* Schw. (1822) of eastern North American *Quercus-Fagus* forest (Tulloss, unpub. data; Z. L. Yang, unpub. data) and Central American *Quercus* forest (Tulloss, R. E. Halling & G. M. Mueller, unpub. data) - stipe exannulate from early development; universal veil not leaving coherent pseudoannuli on stipe and only a thin powdery rim on basal bulb; spores smaller with length (6.0-) 6.5 - 8.8 (-10.5) and **Q** = 1.15 - 1.27 (-1.31); apparently associated with Fagaceae
- *Amanita nehuta* Ridley (1991) of New Zealand - pileus buff; stipe exannulate from early development; inflated cells of universal veil distinctly warted—a cell wall decoration that may be unique in the genus (Tulloss, unpub. data); spores smaller with length 6.5 - 9 μm and **Q** = 1.16; associated with *Kunzea*, *Leptospermum*, and *Nothofagus*
- *Amanita obsita* Corner & Bas (1962) of Singapore - pileus pallid, with pale fuscous disc; stipe exannulate from early development; spores smaller with length 5.8 - 6.7 μm (up to 1.5 μm longer when fresh) and **Q** = 1.1; fruiting "in jungle"
- *Amanita xerocybe* Bas (1978) of Amazonian Brazil - pileus white to pale ochraceous and sometimes browner over disc and having broad umbo at maturity; stipe having persistent annulus; spores smaller with length 7.8 - 9.1 (-9.7) μm and **Q** = 1.0 - 1.05; associated with Sapotaceae and/or Leguminosae.

Another poorly known taxon is sufficiently similar in general habit, pigmentation, spore size and shape, and macroscopic form of universal veil that it might also be considered for comparison—namely *A. umbrinella* E. J. Gilb. & Clel. *in* E. J. Gilb. (1941) of South Australia. The recently proposed name *A. bambra* Grgurinovic (1997) appears to us to be a taxonomic synonym of *A. umbrinella.*

Amanita umbrinella differs from *A. basiana*, additionally, in having

- brief or lacking marginal striations on the pileus
- a median to inferior partial veil that usually persists until maturity and is markedly striate above
- limbate remains of the universal veil more common on the stipe bulb, at least at first
- a pallid stipe that is undecorated or minimally decorated. See illustrations of Gilbert (1941: pl. 23-24).

Amanita bambra was based on collections of Cleland determined by him as *A. grisea* Massee & Rodway. These collections (in AD) are different than those similarly determined collections Cleland sent to Gilbert that served as holotype and paratypes of *A. umbrinella.* However, macroscopic characters in the two protologues are nearly perfectly the same (down to citing, with few exceptions, the same Ridgway color names) and apparently derive from the same pre-1940 publications of Cleland [*e.g.*, (Cleland, 1934)]. Moreover, although little microscopic data are available in the two protologues, the ranges of spore lengths and widths given by Cleland and Gilbert fit within those of Grgurinovic. Approximating **Q'** from the data of Cleland and Gilbert for *A. umbrinella* yields 1.2, which is the value given by Grgurinovic for **Q'** in the case of *A. bambra.* This value is slightly lower than that computed for *A. basiana* and lower than the **Q** value obtained from any single examined specimen of the present species. Treatment of *A. umbrinella* is omitted in Grgurinovic's study.

Singer's concept of *A. umbrinella* based on material so determined from Argentina and Chile is a misapplication of the name. Tulloss (unpub. data) has found South American material of "*A. umbrinella*" determined by Singer (BAFC, F) to include collections of *A. morenoi* Raithelhuber and a species close to, or identical with, *A. diemii* Sing.

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FURTHER STUDIES ON AFRICAN SPECIES OF THE LICHEN GENUS PHYLLOPSORA (LECANORALES)

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ABSTRACT: Twenty species of *Phyllopsora* are recorded from Africa, including the new species *P. africana*, *P. borbonica*, *P. dolichospora*, *P. nemoralis*, and *P. swinscowii*. New chemical strains are recorded in *P. albicans*, *P. chlorophaea*, *P. furfuracea*, and *P. halei*. Lacinules are recognized as vegetative propagules in *P. albicans*, *P. buettneri*, *P. chlorophaea*, *P. confusa*, and *P. mediocris*.

KEYWORDS: Taxonomy, rainforest, Tanzania, Mascarenes.

Introduction

During the last two decades, two major contributions to the taxonomy of the mainly tropical genus *Phyllopsora* Müll. Arg. have appeared (Swinscow & Krog 1981, Brako 1991). Swinscow & Krog (1981) studied the morphology, anatomy, and, when possible, the chemistry of about 90% of the type specimens of the world's reported *Phyllopsora* species, and discussed the delimitation of the genus, the circumscription of the species, and the intraspecific variation. They reported on eleven species of the genus for East Africa, three of which were newly described, reduced a number of names to synonymy, and made several new combinations. Subsequently, one further African species new to science was added (Swinscow & Krog 1986).

In a preliminary report, Brako (1989) presented a revised delimitation of *Phyllopsora* on the basis of a study of all available type specimens of the genus and type material of related genera. Several taxa were excluded from *Phyllopsora*, and the new genus *Squamacidia* Brako was introduced, in anticipation of a forthcoming full monographic treatment of *Phyllopsora*. In a taxonomic monograph for the neotropical species of *Phyllopsora*, Brako (1991) reevaluated the taxonomy on the basis of comparative anatomy, analyses of lichen substances, and ecological observations, and reassessed the species concept. Of the 51 taxa previously described from the Neotropics, she recognized eighteen species and eleven varieties, including one species and one variety described as new, reduced a number of species to synonymy and several others to the variety level. *Phyllopsora longispora* Swinscow & Krog and *P. thaleriza* (Stirton)

Gotth. Schneider, recorded from Africa by Swinscow & Krog (1981, 1986), were excluded from the genus by Brako (1989, 1991).

The purpose of this study is to add to the information on the African species of *Phyllopsora*, particularly those of Tanzania and the Mascarenes, and to evaluate and discuss our species concept in relation to that of Brako (1991).

Materials and Methods

The following account is based mainly on personal field observations and own collections as follows: eastern Tanzania (Krog 1988, 1989), Mauritius (Krog and Timdal 1991), the Seychelles (Krog 1993), and La Réunion (Krog and Timdal 1996). Voucher specimens are deposited in O. The part of the material studied by Swinscow & Krog (1981) which had been deposited in O, was reexamined. Some records based on relevant specimens kindly made available by other collectors are also included. Type material of *P. halei* (Tuck.) Zahlbr., *P. malcolmii* Vězda & Kalb, and *P. subhispidula* (Nyl.) Kalb & Elix was borrowed from H, of *P. mediocris* Swinscow & Krog from UPS, and of *P. parvifolia* (Pers.) Müll. Arg. from BG. The distributions and altitudes given in this paper are based on material examined for this study. Additional East African records cited by Swinscow & Krog (1981) are briefly referred to.

All specimens were subjected to thin-layer chromatography in accordance with the method of Culberson (1972), modified by Menlove (1974) and Culberson & Johnson (1982). Asci were studied in a modified Lugol's solution (water replaced by 50% lactic acid) after pretreatment with 10% KOH. Crystals of calcium oxalate were identified by adding 25% H_2SO_4 under the coverslip and observing precipitation of needle-shaped crystals.

Results

Morphology and anatomy

The morphology and anatomy of *Phyllopsora* have been described in detail by Swinscow & Krog (1981) and Brako (1991). In this study, we have placed further emphasis on the different types of dispersal units. Isidia are well known in the genus, lobules are rarely mentioned, and the presence of soralia has not yet been proved. However, we found that several species had developed a seemingly effective type of dispersal unit, consisting of dorsiventral, apical and/or marginal thallus sections constricted at the base (see Figs 2, 5, 7). Such thalline fragments are easily shed and obviously function as propagules. We shall refer to them in the following as lacinules (lacinule: a small or fine lacinia, see Stearn 1973: 454). In some specimens, there was no sharp difference between the squamule and the lacinule. Lacinules occurred in the following African species: *P. albicans* Müll. Arg., *P. buettneri* (Müll. Arg.) Zahlbr. (main distinguishing feature from *P. subhispidula*), *P. chlorophaea* (Müll. Arg.) Zahlbr. (main distinguishing feature from *P. furfuracea* (Pers.) Zahlbr.), *P. confusa* Swinscow & Krog, and *P. mediocris*. The following were neither isidiate nor lacinulate: *P. borbonica* Timdal & Krog, *P. breviuscula* (Nyl.) Müll. Arg., and *P. mauritiana* (Taylor) Gotth. Schneider; the remaining were isidiate.

We have distinguished between a crustose and a squamiform thallus. The former is formed by areolae, *i.e.* more or less isodiametric thallus elements attached to the prothallus by the entire underside, and the latter by squamules, *i.e.* elongated and/or ascending thallus elements. The squamules were roughly divided into three size classes: small (up to c. 0.3 mm wide), medium sized (0.3 – 0.7 mm), and large (more than 0.7 mm wide).

The types of upper cortex referred to in this paper (type 1, 1–2, and 2), are those described by Swinscow & Krog (1981).

All species had an ascus type conforming to that described by Swinscow & Krog (1981) and Brako (1989, 1991).

In the majority of species the ascospores were simple and ellipsoid to fusiform or shortly, irregularly bacilliform, within the size range 5–15 × 2–5 μm, but in *P. dolichospora* Timdal & Krog they were longly bacilliform, 16–25 × 2–3 μm, and in *P. borbonica* acicular, 20–45 × 2–3 μm. Sparingly septate, acicular ascospores up to 55 μm long were previously known in *P. longispora* (Swinscow & Krog 1986).

Chemistry

The lichen substances encountered in African species of *Phyllopsora* are characterized in Table 1. Table 2 shows the occurrence of diagnostic substances in the various species and chemotypes. When Swinscow & Krog's (1981) publication on the genus *Phyllopsora* appeared, only a few of the lichen substances occurring in the genus, such as atranorin, zeorin, and pannarin, were familiar to the authors. Since then, most of the 'unknown' substances have been identified by names which will be applied in this paper as follows:

Albicans unknown 1 = norargopsin
Albicans unknown 2 = argopsin
Haemophaea unknown = furfuracein
Ochroxantha unknown 1 = phyllopsorin
Ochroxantha unknown 2 = chlorophyllopsorin

Methyl 2,7-dichloropsoromate and methyl 2,7-dichloronorpsoromate, isolated and identified by Elix et al. (1990) from *P. corallina* var. *ochroxantha* (Nyl.) Brako, were recognized by TLC in our new species *P. swinscowii* Timdal & Krog. The determination was verified by Elix (pers. comm.). These substances are identical with the two unknown substances reported by Swinscow & Krog (1981) in an undetermined collection (Santesson 20867a) from Kenya.

The new species *P. dolichospora* contained, in addition to furfuracein, a series of undetermined substances, all PD– and strongly UV+, with R_F values higher than those of furfuracein. Three of them (F1, F2, and F3) are included in Table 1. From their appearance on the chromatograms, they may prove to be related to furfuracein.

In *P. halei*, three chemotypes were encountered. All contained atranorin as a major substance, but differed in the series of accompanying substances consisting of one or two major compounds and several minor compounds or traces. Table 1 characterizes the major compounds only. Terpenoid T3, described by Swinscow & Krog (1981, unnamed), occurred in chemotype I, including type material of the species. Chemotype II was briefly mentioned by Swinscow & Krog (1981: 236), and is here characterized by the major terpenoids T1 and T2. This terpenoid pattern (including minor compounds and

Table 1. R_F values (mm), R_F classes, colour after charring, and UV_{366} fluorescens before charring for lichen substances occurring in the African *Phyllopsora* species*.

Compound	A	B	C	Colour, fluorescens
Argopsin	76 (7–8)	66 (7)	65 (7–8)	brown, UV+
U1	75 (7)	87 (8)	73 (8)	grey, UV–
T3	75 (7)	72 (8)	63 (7)	brownish grey, UV–
Atranorin	75 (7)	66 (7)	63 (7)	brown, UV–
Pannarin	74 (6–7)	57 (6)	63 (7)	dark bluish grey, UV+
Methyl 2,7-dichloropsoromate	74 (6–7)	54 (6)	62 (6–7)	greenish brown, UV+
Chlorophyllopsorin	73 (6–7)	48 (5–6)	60 (6)	yellow, UV+
F3	72 (6)	50 (6)	48 (6)	pale grey, UV+
Norargopsin	71 (6)	56 (6)	59 (6)	brown, UV+
T2	67 (6)	68 (7–8)	55 (6)	greyish violet→blue, UV–
Methyl 2,7-dichloronorpsoromate	67 (6)	44 (5)	54 (6)	yellow, UV+
F2	66 (5–6)	42 (5)	41 (5–6)	pale grey, UV+
F1	62 (5)	40 (5)	30 (5)	pale grey, UV+
Zeorin	59 (5)	40 (5)	38 (5)	greyish violet, UV–
T1	58 (5)	45 (5)	36 (5)	greyish violet→blue, UV–
Furfuracein	58 (5)	33 (5)	17 (3)	pale grey, UV+
Norstictic acid (reference)	54 (4)	30 (4)	26 (4)	orange/yellow, UV+

* UV_{366} fluorescens just after charring: F1–F3: none; T1 and T2: bright green; T3: brown centre, blue periphery; U1: brown. An arrow denotes colour change after 24 hours.

traces) was found to be identical with that of chemotype D which was encountered in the genus *Toninia* A. Massal. by Timdal (1992). Unknown compound U1 occurred, together with some minor compounds and terpenoids, in chemotype III.

On the basis of numerous recent collections, we decided to recognize two chemotypes in *P. albicans*, one with argopsin and norargopsin, the other with argopsin and pannarin, while zeorin, which was considered by Swinscow & Krog (1981) to occur as an accessory substance in this species, proved to be absent. In *P. chlorophaea*, previously considered to lack lichen substances, we discovered a chemotype containing furfuracein, and in *P. furfuracea*, which usually produces furfuracein, we found an additional acid deficient chemotype.

Calcium oxalate was found in the medulla of some specimens of *P. albicans* and *P. subhispidula*; this compound is apparently not previously reported from the genus.

Discussion

Growth form, presence and nature of vegetative propagules, pruinosity and pubescence of thallus, type and thickness of upper cortex, degree of pigmentation in excipulum and hypothecium, ascospore size and shape, and to a certain extent colour and thickness of the prothallus, are in our opinion valuable taxonomic characters in *Phyllopsora*. Non-isidiate specimens of normally isidiate species may occur, but isidia never occur in a non-isidiate species. The prothallus is at first white, becoming more or less reddish brown in most species, but remaining white in some, as, for example, in *P. kalbii* Brako

Table 2. Diagnostic lichen substances occurring in the African *Phyllopsora* species.

Species/chemotype	Atr	Arg	Nrg	Pan	Cph	Mps	Mnp	Fur	F1	F2	F3	U1	Zeo	T1	T2	T3	None
africana	·	○	·	·	●	·	·	·	·	·	·	·	·	·	·	·	·
albicans I	·	●	○	·	·	·	·	·	·	·	·	·	·	·	·	·	·
albicans II	·	●	·	●	·	·	·	·	·	·	·	·	·	·	·	·	·
borbonica	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
breviuscula	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
buettneri	·	·	·	●	·	·	·	·	·	·	·	·	●	·	·	·	·
chlorophaea I	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
chlorophaea II	·	·	·	·	·	·	·	●	·	·	·	·	·	·	·	·	·
confusa	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
corallina	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
dolichospora	·	·	·	·	·	·	·	●	●	○	○	·	·	·	·	·	·
furfuracea I	·	·	·	·	·	·	·	●	·	·	·	·	·	·	·	·	·
furfuracea II	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
halei I	●	·	·	·	·	·	·	·	·	·	·	·	·	·	·	●	·
halei II	●	·	·	·	·	·	·	·	·	·	·	·	·	○	●	·	·
halei III	●	·	·	·	·	·	·	·	·	·	·	●	·	·	·	·	·
kalbii	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
kiiensis	·	·	·	·	·	·	·	●	·	·	·	·	·	·	·	·	·
longispora	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
martinii	·	●	○	·	●	·	·	·	·	·	·	·	·	·	·	·	·
mauritiana	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
mediocris	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	×
nemoralis	○	●	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
subhispidula	·	●	○	·	·	·	·	·	·	·	·	·	●	·	·	·	·
swinscowii	·	·	·	·	·	●	●	·	·	·	·	·	·	·	·	·	·

Atr: atranorin, Arg: argopsin, Nrg: norargopsin, Pan: pannarin, Cph: chlorophyllopsorin, Mps: methyl 2,7-dichloropsoromate, Mnp: methyl 2,7-dichloronorpsoromate, Fur: furfuracein, F1–F3 and U1: unknown substances, Zeo: zeorin, T1–T3: unknown terpenoids. ●: Major, ○: minor.

and the extratropical *P. rosei* Coppins & P. James. In some species, the degree of pigmentation of the prothallus may be a useful character, e.g. in distinguishing between sterile specimens of *P. chlorophaea* and *P. confusa*. We found chemical characters to be of the utmost importance in the circumscription of the species, although chemical strains were occasionally encountered.

Our taxonomic approach differs in many respects from that of Brako (1991). She considered the presence or absence of isidia to be unreliable in most species. This was documented by only one example, namely *P. corallina* var. *santensis* (Tuck.) Brako, which in the field had been found to vary from non-isidiate to densely isidiate on different portions of the same thallus (Brako 1991: 7). As for anatomical characters of the cortex (see Swinscow & Krog 1981, Figs 1, 3, and 4), she found intermediate types common, and concluded that type of cortex varied with developmental stage and ecological conditions. Ascospore sizes were found to be broadly overlapping, and the colour of the prothallus to be a character of low taxonomical value.

In *Phyllopsora*, Brako (1991: 17) found consideration of chemical substances as taxonomic characters complicated by the fact that there were so many unknown compounds. However, in our experience even 'unknown compounds' may be recognized on the TLC plates and considered as diagnostic chemical characters when correlated with morphological and/or anatomical characters. For the detection of secondary compounds by TLC, Brako (1991: 4) claimed to follow Culberson & Kristinsson (1970) and Culberson (1972), as modified by Menlove (1974), 'for most specimens cited'. However, the R_F classes she presented for various compounds sometimes differed from those given by Culberson (1972) and/or our own findings. A few examples follow (Brako's R_F classes in parentheses):

Argopsin. R_F classes 7–8:7:7–8 (6–7:7:7)
Chlorophyllopsorin. R_F classes 6–7:5–6:6 (7–8:7:8)
Pannarin. R_F classes 6–7:6:7 (7:7:7)
Zeorin. R_F classes 5:5:5 (4:4:4)

Phyllopsora corallina var. *ochroxantha* was by Brako (1991: 40) distinguished by the presence of phyllopsorin or chlorophyllopsorin, although it included *P. glabriuscula* (Nyl.) Swinscow & Krog which contains neither. The holotype of *P. martinii* Swinscow & Krog was found to contain phyllopsorin and chlorophyllopsorin, while correctly it contains argopsin, norargopsin, and chlorophyllopsorin.

We agree with Brako (1991) in finding morphological characters in *Phyllopsora* elusive or difficult to interpret in many species. We have therefore chosen to base our first preliminary sorting of the specimens on characters that do not vary with age and environmental conditions, such as the presence and nature of chemical compounds, anatomy of the thallus (we do not believe that characters of the cortex, for example, vary with age and environmental conditions), and characters of apothecia and ascospores. Within the boundaries of the groups of specimens thus obtained, it was possible to assess such characters as presence and nature of vegetative propagules and the development and colour of the prothallus. Although chemical characters were, in our opinion, the most important aid to a preliminary sorting of specimens, chemistry alone was not relied upon for the recognition of species. We discovered, for example, hitherto unrecognized chemical strains in *P. albicans*, *P. chlorophaea*, *P. furfuracea*, and *P. halei*.

Our approach to the taxonomy of the genus is similar to that applied by Swinscow & Krog (1981), but further developed owing to the study of a greater number of freshly collected specimens. We agree with Brako (1989, 1991) in excluding *P. thaleriza* from the genus.

Key to the African *Phyllopsora* species

1. Thallus not isidiate 2
1. Thallus isidiate 9

2. (1) Thallus not lacinulate; no lichen substances present 3
2. Thallus lacinulate; chemistry various 5

3. (2) Thallus composed of large, elongated squamules .... 4. *P. breviuscula*
3. Thallus crustose 4

4. (3) Ascospores acicular, 20–45 µm long .... 3. *P. borbonica*
4. Ascospores ellipsoid, 8.5–10.5 µm long .... 16. *P. mauritiana*

5. (2) Squamules large, PD+ orange (argopsin or pannarin) 6
5. Squamules small to medium sized, PD– (furfuracein, or no lichen substances) 7

6. (5) Squamules pruinose, effuse or forming circular thalli with radiating marginal squamules, containing pannarin and zeorin .... 5. *P. buettneri*
6. Squamules not pruinose, effuse, containing argopsin and either norargopsin or pannarin; zeorin absent .... 2. *P. albicans*

7. (5) Hypothecium reddish brown throughout; thallus containing furfuracein or no lichen substances (often traces of atranorin) .... 6. *P. chlorophaea*
7. Hypothecium colourless to pale brown or patchily reddish brown; thallus containing no lichen substances 8

8. (7) Squamules small and narrow; lacinules coralloid; prothallus thin, white to partly reddish brown .... 7. *P. confusa*
8. Squamules medium sized; lacinules simple; prothallus medium thick, reddish brown .... 17. *P. mediocris*

9. (1) Thallus crustose, or consisting of isidia only 10
9. Thallus squamiform 13

10. (9) Areolae fusing to a continuous, thick crust; K+ yellow (atranorin, with unknown terpenoids or other compounds) .... 11. *P. halei*
10. Areolae, if present, scattered and only patchily fusing; K– (argopsin, or furfuracein ± apparently related compounds, or diagnostic substances absent) 11

11. (10) Isidia mainly simple, PD+ orange (argopsin); hypothecium pale brown to colourless throughout .... 18. *P. nemoralis*
11. Isidia mainly branched, PD– (furfuracein ± apparently related compounds, or lichen substances absent); hypothecium reddish brown in upper part 12

12. (11) Ascospores 7–13 µm long; thallus containing furfuracein only, or lichen substances absent .... 10. *P. furfuracea*
12. Ascospores 16–25 µm long; thallus containing furfuracein and a series of apparently related compounds .... 9. *P. dolichospora*

13. (9) Thallus PD– (furfuracein, or no diagnostic lichen substances) 14
13. Thallus PD+ orange (argopsin or related compounds, zeorin in one species) 17

14. (13) Thallus containing furfuracein .... 13. *P. kiiensis*
14. Thallus not containing diagnostic lichen substances 15

15. (14) Isidia globular, squamules small .... 12. *P. kalbii*
15. Isidia cylindrical, squamules medium sized 16

16. (15) Ascospores acicular, 40–55 µm long .... 14. *P. longispora*
16. Ascospores ellipsoid, 6.5–14.5 µm long .... 8. *P. corallina*

17. (13) Squamules large, pruinose, effuse or forming circular thalli with radiating marginal squamules, containing argopsin, norargopsin, and zeorin .... 19. *P. subhispidula*
17. Squamules medium sized, not pruinose, effuse, chemistry various but zeorin absent 18

18. (17) Thallus containing methyl 2,7-dichloropsoromate and methyl 2,7-dichloronorpsoromate .... 20. *P. swinscowii*
18. Thallus containing argopsin and chlorophyllopsorin 19

19. (18) Squamules rather thick, scattered when young, later contiguous or slightly imbricate, containing also norargopsin; upper cortex of type 2 . 15. *P. martinii*
19. Squamules thin, remaining more or less scattered, not containing norargopsin; upper cortex of type 1–2 .... 1. *P. africana*

1. **Phyllopsora africana** Timdal & Krog, **n. sp.** Fig. 1.

Thallus squamiformis. Squamulae mediocres, adnatae vel ascendentes, isodiametrae vel plus minusve elongatae. Isidia vulgaria, marginalia. Cortex crassus, typo 1–2. Apothecia ad 1.5 mm lata, brunnea. Hypothecium incoloratum. Sporae ellipsoideae, simplices, 5.5–8.5 × c. 2.5 µm. Thallus argopsinum et chlorophyllopsorinum continens.

Type: La Réunion, along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/13 (O, holotype; UPS, isotype).

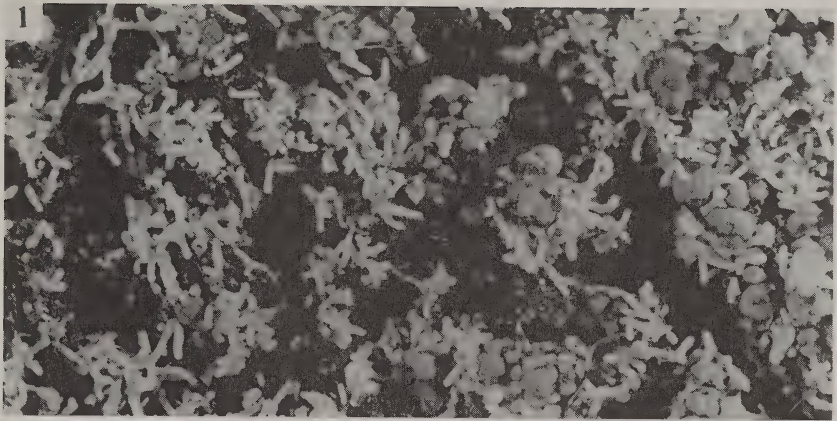
Thallus effuse, squamiform. Prothallus well developed, reddish brown. Squamules medium sized, adnate to ascending, isodiametric to somewhat elongated, scattered when young, later sometimes contiguous or slightly imbricate, crenulate to incised, plane to weakly convex, medium green, glabrous on the upper side, usually faintly pubescent along the margin. Isidia common, attached marginally to the squamules, medium thick, often long, simple to slightly branched. Upper cortex of type 1–2, 30–50 µm thick, containing crystals dissolving in K (PD+ orange, K–); medulla containing crystals partly dissolving in K (PD+ orange, K–).

Apothecia rather common, up to 1.5 mm diam., rounded when young, later of irregular shape, simple to conglomerate, plane to strongly convex, pale to medium brown, with an indistinct, concolorous to darker, glabrous margin. Excipulum pale brown to colourless or with patches of reddish brown pigment; hypothecium colourless; epithecium colourless; no crystals in apothecia. Ascospores ellipsoid, simple, 5.5–8.5 × c. 2.5 µm (n=10).

Pycnidia not seen.

Chemistry: Chlorophyllopsorin (major) and argopsin (minor).

1



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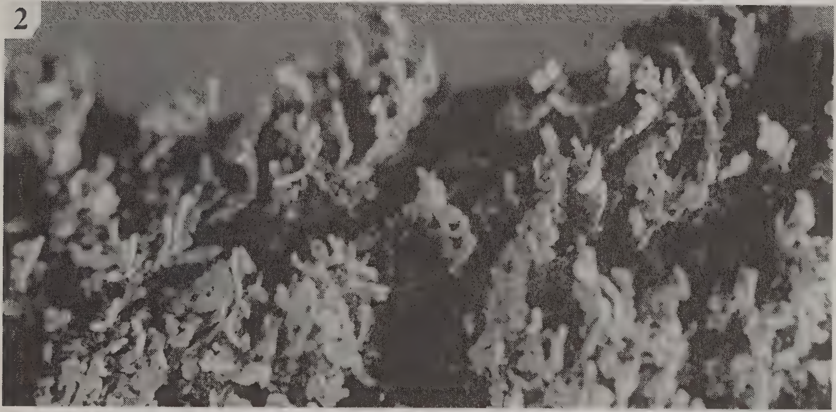

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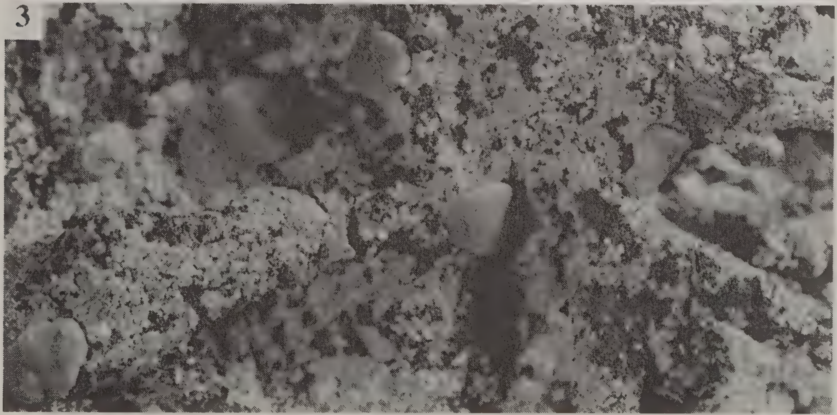


Fig. 1. *Phyllopsora africana*, La Réunion, Krog & Timdal RE8/13 (holotype), 3.6 ×.
Fig. 2. *Phyllopsora albicans*, La Réunion, Krog & Timdal RE8/11, 8 ×.
Fig. 3. *Phyllopsora borbonica*, La Réunion, Krog & Timdal RE8/12 (holotype), 11 ×.

Phyllopsora africana is mainly characterized by a squamiform thallus with marginal, cylindrical isidia, presence of argopsin and chlorophyllopsorin, a thick upper cortex of type 1–2, pale to medium brown apothecia with a usually darker and glabrous margin, and ellipsoid ascospores. It may be confused mainly with *P. corallina*, *P. martinii*, and *P. swinscowii*; see *P. corallina* for discussions.

Phyllopsora africana has been collected in montane rainforest and humid woodland, in Tanzania at 1600–1900 m alt. and in the Mascarenes at 630–1220 m alt.

Specimens examined: **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Luhota Dam and Luhota Forest, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T12/7; – Iringa Distr., Mufindi area, Luisenga, 8°36'S, 35°18'E, 1800 m alt., 1989, Krog 4T16/7, 33; – Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/18; – Iringa Distr., Mufindi escarpment, 2 km NW of Buffalo Hill, 8°40'S, 35°20'E, 1850 m alt., 1989, Krog 4T24/1, 7; – Iringa Distr., Mufindi area, Kigogo forest, 8°40'S, 35°15'E, 1800–1850 m alt., 1989, Krog 4T25/3, 8; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/30; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, Sagara Ridge, 4°49'S, 38°30'E, 1850–1980 m alt., 1988, Krog 2T9/53; – Lushoto Distr., West Usambara Mts, Kwagoroto Summit WNW of Mazumbai village, 4°48'S, 38°29'E, 1850–1950 m alt., 1988, Krog 2T10/40. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/77. **La Réunion**, along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/13 (holotype); – Takamaka, just NE of 'Anc. Cité du P.K. 12', 21°03'S, 55°38'E, 630 m alt., 1996, Krog & Timdal RE22/9.

2. **Phyllopsora albicans** Müll. Arg., *Bull. Soc. r. Bot. Belg.* **32**: 132 (1893). Fig. 2.

Thallus effuse, squamiform. Prothallus usually well developed, reddish brown. Squamules large, ascending, elongated, often imbricate, incised to deeply divided, plane to weakly convex; upper side pale green to medium green, glabrous, epruinose; margin concolorous with upper side, sometimes finely pubescent. Lacinules numerous, developing from lobe-tips. Isidia absent. Upper cortex of type 1, 25–60 µm thick, containing crystals dissolving in K (PD–, K–); medulla containing crystals dissolving in K (PD+ orange, K–) and sometimes calcium oxalate.

Apothecia not common, up to 1.5 mm diam., rounded, simple or slightly conglomerate, weakly to moderately convex, reddish brown, with an indistinct and often darker margin. Excipulum reddish brown throughout; hypothecium pale to medium brown, darkest near the hymenium; hymenium pale brown throughout. No crystals in apothecia. Ascospores narrowly ellipsoid to fusiform or bacilliform, simple, 8.0–12.5 × 2.5–3.5 µm (n=20).

Pycnidia not seen.

Chemistry: Chemotype I: Argopsin (major) and norargopsin (minor). Chemotype II: Argopsin (major) and pannarin (major).

Chemotype II is not previously reported, but common in our material. It is morphologically indistinguishable from chemotype I. The presence of pannarin in chemotype II may lead to confusion with *P. buettneri*, but this species differs morphologically in forming larger, pruinose squamules and more or less circular thalli with radiating marginal squamules, and chemically in producing zeorin.

Phyllopsora albicans has been collected in montane rainforest and humid woodland, in East Africa at 1450–2000 m alt. and in the Mascarenes at 540–1650 m alt.

Specimens examined: Chemotype I: **Kenya**, *Central Prov.*, Kirinyaga Distr., Mt Kenya, 2 km NW of Irangi Forest Station, near river Ena, 0°20'S, 37°28'E, 2000 m alt., 1972, Krog K48/176. **Tanzania**, *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Pócs 88205/s.n. (EGR), Krog 2T6/29; – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/54; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, Sagara Ridge, 4°49'S, 38°30'E, 1850–1980 m alt., 1988, Krog 2T9/52; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, lower part, 4°49'S, 38°30'E, 1300–1500 m alt., 1988, Krog 2T12/41; – Lushoto Distr., West Usambara Mts, along boundary of Mazumbai University Forest Reserve, between Sagara Ridge and motor road, 4°49'S, 38°30'E, 1500–1900 m alt., 1988, Krog 2T13/14; – *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Luhota Dam and Luhota Forest, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T12/1, 6; – Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/2, 6; – Iringa Distr., Mufindi area, Kigogo forest, 8°40'S, 35°15'E, 1800–1850 m alt., 1989, Krog 4T25/1, 2. **Mauritius**, *Savanne*, Mt Cocotte, NW of the peak, 20°26'S, 57°27'E, 680 m alt., 1991, Krog & Timdal MAU22/1; – *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/51; – along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/109; – *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/15; – *Savanne*, Mt Cocotte, along the path towards the peak, 20°26'S, 57°28'E, 750 m alt., 1991, Krog & Timdal MAU32/67; – along the road between Mt Cocotte and Bassin Blanc, 20°26'S, 57°28'E, 550–580 m alt., 1991, Krog & Timdal MAU58/17; – Mt Cocotte, SE of the peak, along the road towards Bassin Blanc, 20°26'S, 57°28'E, 640 m alt., 1991, Krog & Timdal MAU59/20. **La Réunion**, along road towards Plaine d'Affouches, near the kiosk, 20°57'S, 55°25'E, 1230 m alt., 1996, Krog & Timdal RE7/17; – along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/11; – La Vallée Heureuse, along trail above the kiosk, 21°19'S, 55°42'E, 800–830 m alt., 1996, Krog & Timdal RE21/20; – Forêt de Bélouve, track from Gite de Bélouve to viewpoint, 21°03'S, 55°32'E, 1500–1550 m alt., 1996, Krog & Timdal RE25/31; – Forêt de Bébour, along road towards Takamaka, by small bridge c. 700 m (air) WSW of the end of the road, 21°05'S, 55°35'E, 1255 m alt., 1996, Krog & Timdal RE30/10; – La Plain des Lianes, Eden, along trail from the end of the road to kiosk, 21°01'S, 55°38'E, 690–730 m alt., 1996, Krog & Timdal RE31/17; – Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/19, 20; – Cirque de Salazie, along road to Morne de Fourche, 21°02'S, 55°27'E, 1650 m alt., 1996, Krog & Timdal RE39/14; – Col de Bébour, along track towards Plaine des Cafres, 21°07'S, 55°34'E, 1420–1600 m alt., 1996, Krog & Timdal RE40/39; – Le Grand Étang, along the trail from the road to the lake, 21°05'S, 55°39'E, 520–540 m alt., 1996, Krog & Timdal RE48/13.

Chemotype II: **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Lulando Forest at the NE edge of Mufindi escarpment, 8°36'S, 35°37'E, 1450 m alt., 1989, Krog 3T23/49; – Iringa Distr., Mufindi area, Luisenga, 8°36'S, 35°18'E, 1800 m alt., 1989, Krog 4T16/19; – Iringa Distr., Mufindi escarpment, 2 km NW of Buffalo Hill, 8°40'S, 35°20'E, 1850 m alt., 1989, Krog 4T24/3–6. **South Africa**, *Cape Province*, Western Cape, Langeberg Grootvater Bosch forest, c. 22 km NW of Heidelberg, 34°00'S, 20°49'E, 300 m alt., 1996, Moberg 11872 (UPS 155658). **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/71; – *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/24; – *Savanne*, along the road between Mt Cocotte and Bassin Blanc, 20°26'S, 57°28'E, 550–580 m alt., 1991, Krog & Timdal MAU58/20. **La Réunion**, Plaine des Lianes, by the kiosk 0.9 km (air) SSW of Cascade du Chien, 21°01'S, 55°37'E, 740 m alt., 1996, Krog & Timdal RE24/11; – Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/23; – Col de Bébour, along track towards Plaine des Cafres, 21°07'S, 55°34'E, 1420–1600 m alt., 1996, Krog & Timdal RE40/37; – Forêt de Bébour, botanical trail near the beginning of the trail towards Bassin des Hirondelles, 21°07'S, 55°35'E, 1350 m alt., 1996, Krog & Timdal RE42/32; – Forêt de Bébour, along trail towards Takamaka, from the forest station to the edge of the cliff above Ilet à Bananes, 21°05'S, 55°36'E, 1160–1220 m alt., 1996, Krog & Timdal RE46/6; – Forêt de Bébour, upper part of trail towards Bassin des Hirondelles, 21°07'S, 55°35'E, 1300–1340 m alt., 1996, Krog & Timdal RE47/4.

3. **Phyllopsora borbonica** Timdal & Krog, **n. sp.** Fig. 3.

Thallus crustaceus, isidiis et lacinulis destitutus. Cortex tenuis, typo 2. Apothecia ad 2 mm lata, rufa. Hypothecium atrobrunneum vel atrorufum. Sporae aciculares, simplices, 20–45 × 2–3 μm. Acida lichenosa non detecta.

Type: La Réunion, along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/12 (O, holotype; BM, UPS, isotypes).

Thallus effuse, formed by prothallus and small, adnate, isodiametric areolae which are discrete to adjoined peripherally and form a more or less continuous crust centrally. Prothallus medium thick, brownish black. Areolae pale green and glabrous, often pubescent along the margin (at least when discrete). Isidia and lacinules absent. Upper cortex of type 2, 10–15 μm thick; algal layer filling the inner part of the areolae; cortex and algal layer not containing crystals (PD–, K–).

Apothecia abundant, up to 2 mm diam., rounded to flexuose, simple, plane to moderately convex, reddish brown; margin sometimes slightly pubescent when young, paler than the disc, sometimes blackening on the underside. Excipulum pale brown to colourless in inner part, pale brown to dark reddish brown in the rim; hypothecium dark brown to reddish brown in the upper part, paler in the lower part; epithecium colourless. No crystals in apothecia; reddish brown pigment in excipulum and hypothecium K+ purple. Ascospores acicular, simple, 20–45 × 2–3 μm (n=38).

Pycnidia not seen.

Chemistry: No lichen substances.

This crustose species is included in *Phyllopsora* mainly on the basis of the following features: spongy brownish black prothallus colonized by scattered, often pubescent areolae which later fuse; apothecia with a slightly pubescent margin; upper cortex of type 2, lacking an epinecral layer; strongly gelatinized hypothecium merging into the excipulum; and simple ascospores. *Bacidia* De Not. and *Bacidina* Vězda, as circumscribed by Ekman (1996), have an epinecral layer in the upper cortex; no spongy prothallus; hypothecium not strongly gelatinized, and of distinctly different texture than the excipulum; and 3- to pluriseptate ascospores.

The species is most similar to *P. mauritiana*, but differs in having a more effuse growth form and thinner prothallus; darker apothecia which often turn black on the underside; and longer, acicular ascospores. Acicular ascospores are unusual in *Phyllopsora*, known in Africa only in the squamiform, isidiate species *P. longispora* (Swinscow & Krog 1986).

Phyllopsora borbonica has been collected in humid woodland at 540–1255 m alt.

Specimens examined: **Mauritius**, *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU13/8. **La Réunion**, Forêt de Bébour, along road towards Takamaka, by small bridge c. 700 m (air) WSW of the end of the road, 21°05'S, 55°35'E, 1255 m alt., 1996, Krog & Timdal RE30/11; – Le Grand Étang, along the trail from the road to the lake, 21°05'S, 55°39'E, 520–540 m alt., 1996, Krog & Timdal RE48/14; – along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/12 (holotype).

4. Phyllopsora breviuscula (Nyl.) Müll. Arg., *Bull. Herb. Boissier* **2** (app. 1): 45 (1894). Fig. 4.

Thallus effuse or forming incomplete circular patches, squamiform. Prothallus thick, reddish brown. Squamules large, adnate, elongated, contiguous or partly imbricate, soon becoming deeply divided, distinctly convex, medium green or often with brown patches, glabrous above, pubescent along the margin. Isidia and lacinules absent. Upper cortex of type 1–2, 30–70 µm thick; cortex and medulla not containing crystals (PD–, K–).

Apothecia common, up to 2 mm diam., rounded, simple or conglomerate, plane to moderately convex, medium brown, with a paler, glabrous, often indistinct margin. Excipulum pale brown or with deeper brown patches; hypothecium pale brown in lower part, medium brown in upper part; epithecium medium brown; no crystals in apothecia (all parts K–). Ascospores rather broadly ellipsoid to fusiform, simple, 9.5–13 × 3.5–5 µm (n=15).

Pycnidia not seen.

Chemistry: No lichen substances.

Brako (1991) treated the species as a variety of *P. parvifolia*. Parvifoliin, a PD– substance in R_F classes 5–6:6:6 (Brako 1991: 17), was discovered by HPLC in *P. parvifolia* and said to be diagnostic for the species (p. 53). However, according to Table II (p. 20) both varieties accepted from the Neotropics were acid deficient. The same is the case for three type specimens regarded as belonging in the species (*Lecidea parvifolia* var. *concrescens* Malme, *P. weberi* Ferraro, and *Lecidea breviuscula* Nyl.; pp. 53, 56). According to Brako (1991: 42), parvifoliin is also a diagnostic compound in *P. corallina* var. *rappiana* Brako. We have not found any other references to parvifoliin in the literature.

Phyllopsora breviuscula has been collected in humid to wet woodland at 300–1390 m alt. Swinscow & Krog (1981) recorded the species from Usambara, Tanzania (type specimen of *P. brachyspora* Müll. Arg.).

Specimens examined: **Mauritius**, *Grand Port*, Montagnes Bambou, 0.5–1 km NNE of Piton Rouge, 20°20'S, 57°44'E, 250–300 m alt., 1991, Krog & Timdal MAU36/8; – *Black River*, Macchabee Forest, along the path to Mt Bris Fer, 20°23'S, 57°26'E, 560–620 m alt., 1991, Krog & Timdal MAU64/27. **La Réunion**, Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/18.

5. Phyllopsora buettneri (Müll. Arg.) Zahlbr., *Cat. Lich. Univ.* **4**: 396 (1926). Fig. 5.

Thallus squamiform, effuse or circular with radiating marginal squamules. Prothallus usually well developed, reddish brown. Squamules large, adnate or ascending, elongated, incised to deeply divided, plane to weakly convex; upper side pale green to medium green, glabrous or pruinose in inner part, usually distinctly pruinose towards the lobe-ends; margin pale, pubescent. Lacinules numerous, developing from the tips of ascending lobes, mainly in the inner part of the thallus. Isidia absent. Upper cortex of type 1 (–2), 30–70 µm thick, containing scattered crystals dissolving in K (PD–, K–); medulla containing crystals partly dissolving in K and in 25% H_2SO_4 (PD+ orange, K–).

Apothecia rare (seen in a single collection), up to 1.5 mm diam., rounded, simple to conglomerate, convex and immarginate even when young, dark reddish brown.

Excipulum medium brown in inner part, dark reddish brown in the rim; hypothecium pale to medium brown; hymenium reddish brown throughout. No crystals in apothecia. Ascospores not seen (10–15 × 2.5–3 µm, Swinscow & Krog 1981).

Pycnidia not seen.

Chemistry: Pannarin (major) and zeorin (major).

Brako (1991) recognized three varieties of this species, mainly on the basis of chemical characters. Our material conforms chemically to her var. *buettneri*. She included both isidiate and non-isidiate specimens in the species, apparently also in all three varieties. We believe the species propagates by lacinules, and include morphologically similar, but isidiate specimens in *P. subhispidula*. That species also differs in chemistry (argopsin, norargopsin, zeorin, ± atranorin).

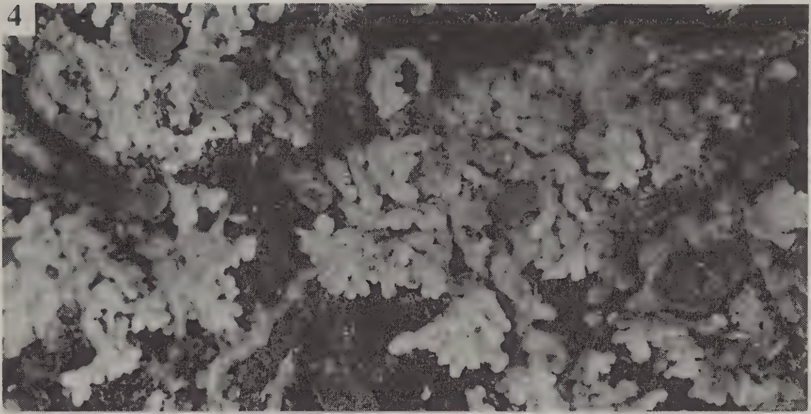
Phyllopsora buettneri has been collected in montane rainforest and humid woodland, in Tanzania at 1200–1800 m alt. and in the Mascarenes at 540–1390 m alt. Swinscow & Krog (1981) recorded the species also from Uganda.

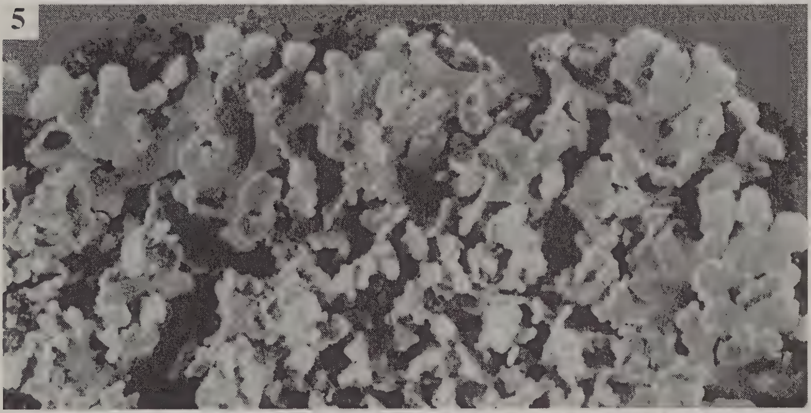
Specimens examined: **Tanzania**, *Eastern Prov.*, Morogoro Distr., SE slope of Kanga Mt. along Mkange stream, 6°00'E, 37°43'E, 1000–1200 m alt., 1989, Krog 3T14/16a; – *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/16; – Iringa Distr., Mufindi area, Kigogo forest, 8°40'S, 35°15'E, 1800–1850 m alt., 1989, Krog 4T25/7; – *Tanga Prov.*, Lushoto Distr., – West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/28; Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/53; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, lower part, 4°49'S, 38°30'E, 1300–1500 m alt., 1988, Krog 2T12/40. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/76, 85; – Macchabee Forest, along the path to Mt Bris Fer, 20°23'S, 57°26'E, 560–620 m alt., 1991, Krog & Timdal MAU64/25; – along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/46, 47; – *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/11. **La Réunion**, Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/16; – Le Grand Étang, along the trail from the road to the lake, 21°05'S, 55°39'E, 520–540 m alt., 1996, Krog & Timdal RE48/16.

6. Phyllopsora chlorophaea (Müll. Arg.) Zahlbr., *Denkschr. Akad. Wiss. Wien* 83: 133 (1909). Fig. 6.

Thallus effuse, squamiform. Prothallus well developed, reddish brown. Squamules small, at first adnate, isodiametric, and plane to weakly convex, soon becoming deeply incised, later ascending, flat to concave, and by repeated marginal proliferations becoming lacinulate, medium to dark green, glabrous or often finely pubescent along the margin. Lacinules coralloid and more or less imbricate. Isidia absent. Upper cortex of type 1–2, 20–40 µm thick; upper cortex and medulla containing scattered crystals dissolving in K (chemotype II) (PD–, K–).

Apothecia not rare, up to 1.5 mm diam., plane to convex, dark brown, when young more or less rounded, simple, and with a distinct, glabrous, dark brown to black margin, later of more irregular shape and usually conglomerate and immarginate. Excipulum and hypothecium dark reddish brown throughout, containing scattered crystals dissolving in K (chemotype II), K+ faintly purple; epithecium pale brown to colourless. Ascospores narrowly ellipsoid to fusiform, simple, 7–12.5 × 2.5–3 µm (n=40).





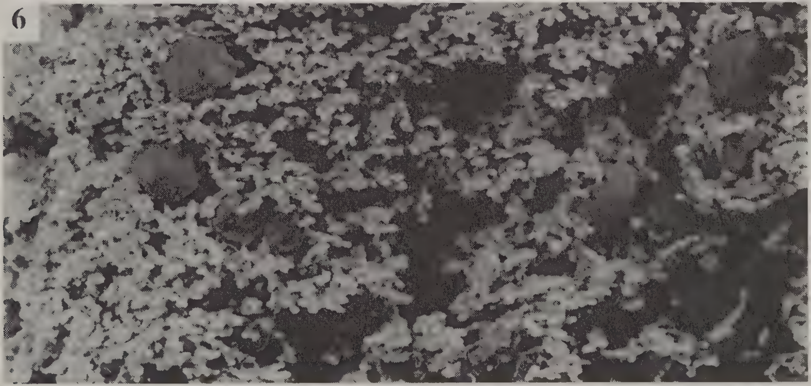


Fig. 4. *Phyllopsora breviuscula*, La Réunion, Krog & Timdal RE36/18, 5.8 ×.
Fig. 5. *Phyllopsora buettneri*, La Réunion, Krog & Timdal RE36/16, 5.8 ×.
Fig. 6. *Phyllopsora chlorophaea*, La Réunion, Krog & Timdal RE36/17, 5.8 ×.

Pycnidia not seen.

Chemistry: Chemotype I: Atranorin (trace) or no lichen substances. Chemotype II: Furfuracein (major) and often atranorin (trace).

Chemotype II is not previously reported, but common in our material. It is morphologically indistinguishable from chemotype I. The presence of furfuracein indicates an affinity with *P. furfuracea*, from which it differs mainly in producing lacinules, not isidia. *Phyllopsora chlorophaea* also has a thicker upper cortex and more deeply pigmented excipulum and hypothecium than *P. furfuracea*. The deep reddish brown hypothecium distinguishes it from the other lacinulate species of *Phyllopsora* (e.g. *P. confusa*, see that species for discussion).

The species has been collected in montane rainforest and humid woodland, in East Africa at 1200–2000 m alt. and in the Mascarenes at 600–1550 m alt.

Specimens examined: Chemotype I: **Kenya**, *Central Prov.*, Kirinyaga Distr., Mt Kenya, 2 km NW of Irangi Forest Station, near river Ena, 0°20'S, 37°28'E, 2000 m alt., 1972, Krog K48/175. **Tanzania**, *Eastern Prov.*, Morogoro Distr., SE slope of Kanga Mt. along Mkange stream, 6°00'E, 37°43'E, 1000–1200 m alt., 1989, Krog 3T14/16b; – *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/7; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, between Mazumbai University Forest Station and Kambi Falls, 4°48'S, 38°30'E, 1600–1700 m alt., 1988, Krog 2T7/39; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, Sagara Ridge, 4°49'S, 38°30'E, 1850–1980 m alt., 1988, Krog 2T9/49, 51. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/48. **La Réunion**, W edge of Basse Vallée, along trail to Piton Larde, 21°19'S, 55°41'E, 750–985 m alt., 1996, Kis 9651/CT (EGR); – Forêt de Bélouve, along the trail from the forest station to Pic des Chevres, 21°03'S, 55°32.2'E, 1550–1610 m alt., 1996, Gyarmati 9617/GA (EGR); – Forêt de Bélouve, track from Gite de Bélouve to viewpoint, 21°03'S, 55°32'E, 1500–1550 m alt., 1996, Krog & Timdal RE25/33; – Col de Bébour, along track towards Plaine des Cafres, 21°07'S, 55°34'E, 1420–1600 m alt., 1996, Krog & Timdal RE40/33, 34, 36, 38, 40, 47; – Forêt de Bébour, botanical trail near the beginning of the trail towards Bassin des Hirondelles, 21°07'S, 55°35'E, 1350 m alt., 1996, Krog & Timdal RE42/30, 31.

Chemotype II: **Tanzania**, *Tanga Prov.*, Lushoto Distr., West Usambara Mts, between Mazumbai University Forest Station and Kambi Falls, 4°48'S, 38°30'E, 1600–1700 m alt., 1988, Krog 2T7/37; – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/46; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, lower part, 4°49'S, 38°30'E, 1300–1500 m alt., 1988, Krog 2T12/38. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/45, 49, 52, 53; – along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/72, 73, 75, 79, 82, 84; – *Moka*, Mt Le Pouce, 20°12'S, 57°31'E, 730–750 m alt., 1991, Krog & Timdal MAU47/13, 14, 20; – *Savanne*, Mt Cocotte, NW of the peak, 20°26'S, 57°27'E, 680 m alt., 1991, Krog & Timdal MAU22/14; – Mt Cocotte, along the path towards the peak, 20°26'S, 57°28'E, 750 m alt., 1991, Krog & Timdal MAU32/68. **La Réunion**, along road towards Plaine d'Affouches, near the kiosk, 20°57'S, 55°25'E, 1230 m alt., 1996, Krog & Timdal RE7/19; – along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/10; – La Vallée Heureuse, along trail above the kiosk, 21°19'S, 55°42'E, 800–830 m alt., 1996, Krog & Timdal RE21/19; – La Plain des Lianes, Eden, along trail from the end of the road to kiosk, 21°01'S, 55°38'E, 690–730 m alt., 1996, Krog & Timdal RE31/18; – La Plain des Lianes, 200–300 m SSW of the kiosk c. 900 m SSW of Cascade du Chien, 21°01'S, 55°37'E, 750 m alt., 1996, Krog & Timdal RE32/12; – Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/17, 21; – Col de Bébour, along track towards Plaine des Cafres, 21°07'S, 55°34'E, 1420–1600 m alt., 1996, Krog & Timdal RE40/43, 44; – Forêt de Bébour, botanical trail near the beginning of the trail towards Bassin des Hirondelles, 21°07'S, 55°35'E, 1350 m alt., 1996, Krog & Timdal RE42/33; – Le Gros Piton Rond, 21°08'S, 55°36'E, 1420 m alt., 1996, Krog & Timdal RE50/5, 6.

7. Phyllopsora confusa Swinscow & Krog, *Lichenologist* **13**: 229 (1981). Fig. 7.

Thallus effuse, squamiform. Prothallus thin, but often well developed, white to partly reddish brown. Squamules small, narrow, ascending, lacinulate, imbricate, plane to weakly convex, medium green, glabrous or finely pubescent along the margin. Lacinules coralloid. Isidia absent. Upper cortex of type 2, 15–20 μm thick; upper cortex and medulla not containing crystals (PD–, K–).

Apothecia not rare, up to 3 mm diam., rounded to irregular, simple, plane to moderately convex, pale to medium brown, with an indistinct, usually paler, glabrous margin. Excipulum pale brown in inner part, darker in the rim; hypothecium pale brown in lower part, darker in upper part; epithecium colourless; excipulum, hypothecium, and hymenium colourless or patchily tinged reddish brown; no crystals in apothecia. Ascospores narrowly ellipsoid to shortly bacilliform, simple, 9–11 × 2–2.5 μm (n=22).

Pycnidia not seen.

Chemistry: No lichen substances, or at most traces of terpenoids.

Phyllopsora confusa may be confused mainly with *P. chlorophaea* and *P. mediocris*. It differs from the acid deficient chemotype of the former in having a thinner, less pigmented prothallus; paler apothecia with a margin which is usually paler than the disc; and pale brown inner parts of the excipulum and hypothecium (at most patchily dark reddish brown). In *P. chlorophaea* the apothecial margin is darker than the disc, and the excipulum and hypothecium are dark reddish brown throughout. For differences from *P. mediocris*, see that species.

The species has been collected in montane rainforest and humid woodland, in East Africa at 1800–2000 m alt. and in the Mascarenes at 130–700 m alt.

Specimens examined: **Kenya**, *Central Prov.*, Kirinyaga Distr., Mt Kenya, 2 km NW of Irangi Forest Station, near river Ena, 0°20'S, 37°28'E, 2000 m alt., 1972, Krog & Swinscow K48/177 (O, holotype). **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/1, 5; – Iringa Distr., Mufindi area, Kigogo forest, 8°40'S, 35°15'E, 1800–1850 m alt., 1989, Krog 4T25/4. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/81; – *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/14, 18, 21. **La Réunion**, On road towards Mare Longue nature reserve, 21°21'S, 55°45'E, 130 m alt., 1996, Krog & Timdal RE17/4; – La Plain des Lianes, Eden, along trail from the end of the road to kiosk, 21°01'S, 55°38'E, 690–730 m alt., 1996, Krog & Timdal RE31/19.

8. Phyllopsora corallina (Eschw.) Müll. Arg., *Bot. Jb.* **20**: 264 (1894). Fig. 8.

Thallus effuse, squamiform. Prothallus indistinct to partly well developed, white to reddish brown. Squamules medium sized, adnate to ascending, isodiametric to elongated, scattered when young, later often contiguous or imbricate, crenulate to incised, plane to weakly convex, medium green, glabrous on the upper side, usually faintly pubescent along the margin. Isidia common, attached marginally to the squamules, thin to medium thick, long, simple or rarely branched. Upper cortex of type 2, 15–25 μm thick; cortex and medulla not containing crystals (PD–, K–).

Apothecia rather common, up to 1.5 mm diam., rounded when young, later of irregular shape, mainly simple, plane to moderately convex, pale to medium brown, with an indistinct, usually slightly paler, glabrous to finely pubescent margin. Excipulum pale brown to colourless; hypothecium pale brown to colourless; epithecium colourless; no crystals in apothecia. Ascospores narrowly ellipsoid to shortly bacilliform, simple, 6.5–14.5 × 2–2.5 µm (n=31).

Pycnoconidia bacilliform, 5–10 × c. 1 µm.

Chemistry: No lichen substances.

As presented by Brako (1991), *P. corallina* is distinguished by its small to medium sized squamules, abundant isidia, and orange-brown or reddish apothecia. Aside from var. *corallina*, five further varieties were recognized, which made *P. corallina* a species in which a number of morphological, anatomical, and chemical characters, many of them commonly considered to be of taxonomic value at species level, occurred in various combinations. The species might comprise specimens with small to medium sized or large squamules, be isidiate or non-isidiate, have a cortex of type 1, 1–2, or 2, have laminal or marginal, globose or elongated, cylindrical or flattened isidia, and a complicated chemistry ranging from acid deficient to various combinations of atranorin, argopsin, norargopsin, vicanicin, norvicanicin, phyllopsorin, chlorophyllopsorin, methylphyllopsorate, methylchlorophyllopsorate, parvifoliin, zeorin, and unknowns. (In the key to the varieties of *P. corallina* on p. 38, under '1a. Thallus PD–', one should probably read 'parvifoliin' instead of 'phyllopsorin', since phyllopsorin is PD+ and parvifoliin, not phyllopsorin, was said to occur in var. *rappiana* on pp. 20 and 42.)

In our material, there are correlations between secondary chemistry and thallus morphology, and we prefer to keep the here recognized taxa at species level. Common features for the five species discussed below are: prothallus reddish brown, usually well developed; thallus squamiform, effuse; isidia cylindrical, simple to slightly branched, attached marginally to the squamules; and hypothecium colourless to pale brown. The morphological differences are sometimes small, more like statistical trends than diagnostic features, and examination by TLC is usually necessary for identifying the species.

Phyllopsora corallina lacks secondary compounds, has a thin upper cortex of type 2, pale to medium brown apothecia with a usually slightly paler and glabrous to finely pubescent margin, and narrowly ellipsoid to shortly bacilliform ascospores.

Phyllopsora africana contains argopsin and chlorophyllopsorin, has a thick upper cortex of type 1–2, pale to medium brown apothecia with a usually darker and glabrous margin, and ellipsoid ascospores.

Phyllopsora kiiensis contains furfuracein, has a thin upper cortex of type 2, medium brown apothecia with a usually slightly paler and pubescent margin, and narrowly ellipsoid to shortly bacilliform ascospores. It differs morphologically from *P. corallina* in forming more adnate and isodiametric squamules and in having a more pubescent apothecial margin.

Phyllopsora martinii contains argopsin, norargopsin, and chlorophyllopsorin, has a thick upper cortex of type 2, pale to medium brown apothecia with a usually darker and glabrous margin, and ellipsoid ascospores. It is morphologically most similar to *P. africana*, but differs in containing an additional compound (norargopsin), forming thicker and more contiguous squamules, and in having more rounded lumina in the upper cortex (type 2). *Phyllopsora martinii* occurs in dryer habitats and at lower altitudes than *P. africana*.

Phyllopsora swinscowii contains methyl 2,7-dichloropsoromate and methyl 2,7-dichloronorpsoromate, has a medium thick upper cortex of type 1–2, medium to dark

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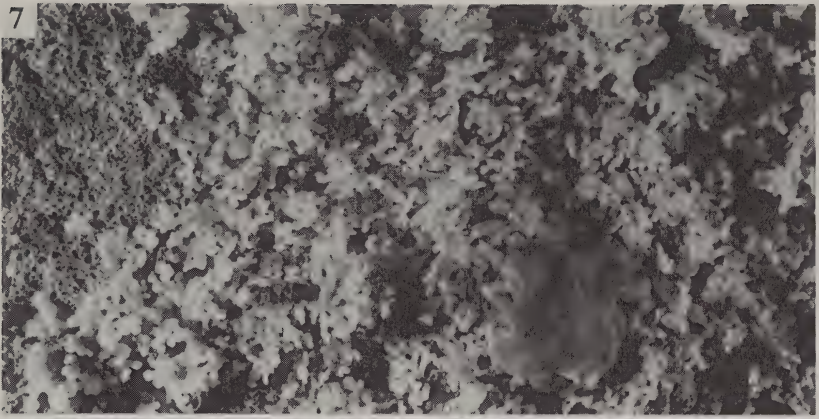

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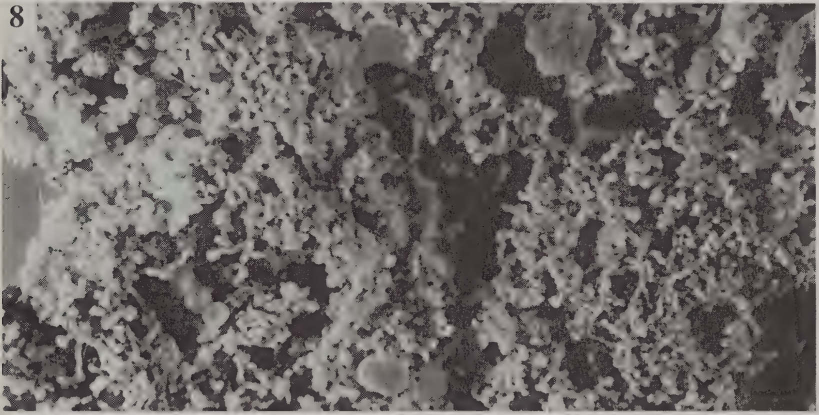

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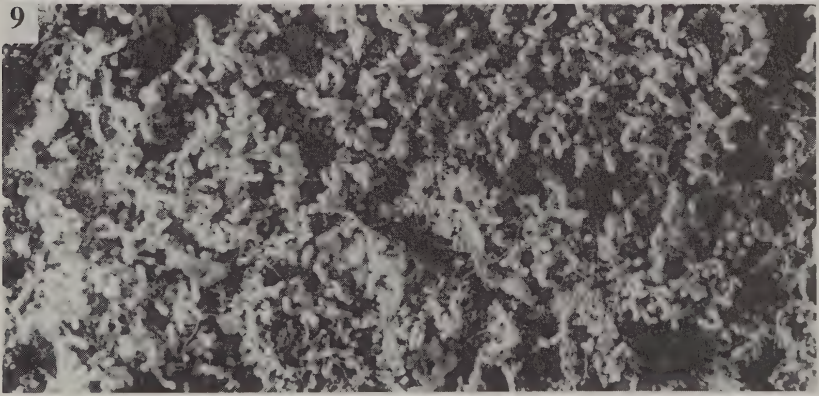

Fig. 7. *Phyllopsora confusa*, Mauritius, Krog & Timdal MAU51/81, 6.8 ×.

Fig. 8. *Phyllopsora corallina*, Seychelles, Krog SEY3/1, 9 ×.

Fig. 9. *Phyllopsora dolichospora*, Mauritius, Krog & Timdal MAU65/22 (holotype), 7.3 ×.

brown apothecia with a concolorous, glabrous to pubescent margin, and narrowly ellipsoid ascospores. It is morphologically most similar to *P. africana*, but differs in forming a somewhat thinner upper cortex, having darker apothecia without reddish brown pigment in the excipulum, and more narrowly ellipsoid ascospores. *Phyllopsora corallina* has a thinner upper cortex with more rounded lumina, paler apothecia, and somewhat longer ascospores.

Phyllopsora corallina has been collected in semihumid to humid woodland, in East Africa from sea level to 1800 m alt. and in the Seychelles from sea level to 460 m alt.

Specimens examined: **Ethiopia**, *Shewa Prov.*, Wondo Gennet, 20 km S of Shashemenne, 1800–2000 m alt., 1972, Krog E5/79. **Tanzania**, *Eastern Prov.*, Rufiji Distr., Juani Island, near the northern tip of the island, 8°00'S, 39°47'E, 3–4 m alt., 1989, Krog 4T5/8, 9; – *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/17b; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/52. **South Africa**, *Cape Province*, Albany District, Kern Kloof, near Grahamstown, c. 600 m alt., 1953, Almborn 10814 (O) [Almborn, lich. afr. 113]. **Seychelles**, *Mahé Island*, Morne Seychellois Nat. Park, from Sans Souci Forest Station along path to Trois Frères, 4°38'S, 55°27'E, 230–450 m alt., 1993, Krog SEY3/1; – Morne Seychellois Nat. Park, along trail from Forêt Noire road to Mission ruins, 4°39'S, 55°26'E, 460 m alt., 1993, Krog SEY4/1; – SE of Victoria along Mont Fleuri road, in the Botanic Garden, 4°38'S, 55°28'E, 20–30 m alt., 1993, Krog SEY6/1; -–NE coast, 7.5 km SE of Victoria, above Cascade village, along River Cascade, 4°40'S, 55°30'E, 60–200 m alt., 1993, Krog SEY10/1; – southern part of the island, along Chemin Mon Plaisir from Anse Royale to Anse Boileau Bay, 4°44'S, 55°30–31'E, 20–200 m alt., 1993, Krog SEY24/1, 2; – W coast of central Mahé, hill S of Anse Boileau village, 4°43’10"S, 55°28’55"E, 50–100 m alt., 1993, Pócs 9330 (EGR).

9. **Phyllopsora dolichospora** Timdal & Krog, **n. sp.** Fig. 9.

Thallus crustaceus vel solum ex isidiis constans. Isidia vulgaria. Cortex tenuis, typo 2. Apothecia ad 2 mm lata, brunnea. Hypothecium pallide brunneolum vel rufum. Sporae bacilliformes, simplices, 16–25 × 2–3 µm. Thallus furfuraceinum et substantiae ignotae continens.

Type: Mauritius, Plaines Wilhems, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/22 (O, holotype).

Thallus effuse, formed by prothallus and partly by minute areolae which often fuse and form a continuous crust and partly by isidia; isidia often dominating. Prothallus indistinct to well developed, white to reddish brown. Areolae adnate, isodiametric, plane to weakly convex, medium to dark green, glabrous or pubescent along the margin. Isidia abundant, medium thick, often long, medium to dark green, glabrous, simple to branched or sometimes coralloid, often curved, adnate to ascending. Upper cortex of type 2, 5–15 µm thick, not containing crystals (PD–, K–); medulla containing crystals dissolving in K (PD–, K–).

Apothecia common, up to 2 mm diam., of irregular shape, usually conglomerate, plane to weakly convex, medium to dark brown, with an indistinct, often slightly paler, glabrous or pubescent (especially when young) margin. Excipulum pale brown, with scattered darker brown patches, containing colourless crystals dissolving in K; hypothecium pale brown in lower part, more reddish brown in upper part, containing some scattered colourless crystals dissolving in K, K–; epithecium pale brown. Ascospores bacilliform, simple, 16–25 × 2–3 µm (n=20).

Pycnidia not seen.

Chemistry: Furfuracein (major) and a series of unknown compounds (F1, F2, and F3 are characterized here).

Phyllopsora dolichospora appears to be morphologically indistinguishable from *P. furfuracea*, but differs in having longer ascospores and in containing compounds not occurring in *P. furfuracea*.

The species has been collected in montane rainforest and humid woodland, in Tanzania at 1450–1600 m alt. and in Mauritius at about 600 m alt.

Specimens examined: **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Lulando Forest at the NE edge of Mufindi escarpment, 8°36'S, 35°37'E, 1450 m alt., 1989, Krog 3T23/18b; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, between Mazumbai University Forest Station and Kambi Falls, 4°48'S, 38°30'E, 1600–1700 m alt., 1988, Krog 2T7/38. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 620–828 m alt., 1991, Krog & Timdal MAU51/74; – *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/22 (holotype).

10. **Phyllopsora furfuracea** (Pers.) Zahlbr., *in* Engler & Prantl, *Nat. Pflanzenfam.* **1(1*)**: 138 (1905). Fig. 10.

Thallus effuse, formed by prothallus and partly by minute areolae which often fuse and form a continuous crust and partly by isidia developing directly from the prothallus; isidia often dominating. Prothallus indistinct to well developed, white to reddish brown. Areolae adnate, isodiametric, plane to weakly convex, medium to dark green, glabrous or rarely pubescent along the margin. Isidia usually abundant, medium thick, often long, medium to dark green, often with a brown tinge, glabrous, simple to branched or sometimes coralloid, often curved, adnate to ascending. Upper cortex of type 2, 5–15 µm thick, not containing crystals (PD–, K–); medulla containing crystals dissolving in K (chemotype I) or not containing crystals (chemotype II) (PD–, K–).

Apothecia common, up to 2 mm diam., of irregular shape, usually conglomerate, convex, pale brown to dark reddish brown, immarginate or with an indistinct, often slightly paler, glabrous or pubescent (especially when young) margin. Excipulum pale brown, with scattered darker brown patches, containing colourless crystals dissolving in K (chemotype I); hypothecium pale brown in lower part, more reddish brown in upper part, containing some scattered colourless crystals dissolving in K (chemotype I), K–; epithecium pale brown. Ascospores narrowly ellipsoid, simple, 7–13 × 2–3 µm (n=40).

Pycnidia not seen.

Chemistry: Chemotype I: Furfuracein. Chemotype II: No lichen substances.

Phyllopsora furfuracea was previously known to contain furfuracein. We now report acid deficient specimens of this species (chemotype II). Furfuracein also occurs in three additional species: *P. chlorophaea* (chemotype II), *P. dolichospora*, and *P. kiiensis*; see those species for discussions.

The species has been collected in montane rainforest and humid woodland, in East Africa at 900–2400 m alt. and in La Réunion at 540–1650 m alt. Swinscow & Krog (1981, as *P. haemophaea* (Nyl.) Müll. Arg.) recorded chemotype I also from Ethiopia and Kenya.

Specimens examined: Chemotype I: **Tanzania**, *Eastern Prov.*, Morogoro Distr., Uluguru Mts, E edge of Lukwangule Plateau, 2400 m alt., 1988, Pócs & Ochyra 88110/BS, BT (EGR); – Morogoro Distr., Lukwangule Plateau, in Mgeta River Valley on the E escarpment, 2300 m alt., 1988, Pócs & Ochyra 88113/E (EGR); – Morogoro Distr., SE slope of Kanga Mt. along Mkange stream, 6°00'S, 37°43'E, 1000–1200 m alt., 1989, Krog 3T14/43; – *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Luhota Dam and Luhota Forest, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T12/3, 4; – Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/8–14; – Iringa Distr., Mufindi area, Kigogo forest, 8°40'S, 35°15'E, 1800–1850 m alt., 1989, Krog 4T25/5; – *Tanga Prov.*, Lushoto Distr., [East] Usambara Mts, Amani, in the surroundings of Forestry House, 5°07'S, 38°38'E, c. 900 m alt., 1971, Moberg 1481c p.p. (UPS 29084) & Santesson 23292 (UPS); – Lushoto Distr., East Usambara Mts, Kwamkoro F.R., [5°08'S, 38°25'E,] 1000 m alt., 1987, Pócs & Mwasha 87032 (VBI); – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/47. **South Africa,** *Cape Province*, Eastern Cape, Grootrivier (1 km N of Natures Valley) not far from the bridge, 33°58'S, 23°34'E, 10 m alt., 1996, Moberg 11833 (UPS 155657) – Western Cape, Ysternek National Park, lower part, 2 km NE of Diepwalle, 33°56'S, 23°11'E, 450 m alt., 1996, Moberg 11821 (UPS 155655) & Nordin 4620 (UPS 162641). **La Réunion**, Ravine Grand Galet at the SW side of Piton de la Fournaise volcano, 21°15.2'S, 55°40.1'E, 1200–1400 m alt., 1996, Pócs & Szabo 9684/C (EGR); – along road towards Plaine d'Affouches, near the kiosk, 20°57'S, 55°25'E, 1230 m alt., 1996, Krog & Timdal RE7/18; – along road towards Plaine d'Affouches, above Bras Citron, at point where road meets track, 20°57'S, 55°25'E, 1220 m alt., 1996, Krog & Timdal RE8/14; – Takamaka, along trail from the end of the road towards Forêt de Bébour, 21°05'S, 55°37'E, 800–830 m alt., 1996, Krog & Timdal RE23/9; – Forêt de Bébour, along the road, c. 700 m (air) SE of Piton des Trois Mares, 21°05'S, 55°34'E, 1410 m alt., 1996, Krog & Timdal RE28/12; – Cirque de Cilaos, along road towards Bras Sec, at intersection with canyon of Bras de Benjoin, 21°06'S, 55°29'E, 1360 m alt., 1996, Krog & Timdal RE35/12; – Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/22; – Cirque de Salazie, along road to Morne de Fourche, 21°02'S, 55°27'E, 1650 m alt., 1996, Krog & Timdal RE39/13; – Col de Bébour, along track towards Plaine des Cafres, 21°07'S, 55°34'E, 1420–1600 m alt., 1996, Krog & Timdal RE40/35, 41, 42, 45; – Forêt de Bébour, along trail towards Takamaka, from the forest station to the edge of the cliff above Ilet à Bananes, 21°05'S, 55°36'E, 1160–1220 m alt., 1996, Krog & Timdal RE46/4, 5; – Le Grand Étang, along the trail from the road to the lake, 21°05'S, 55°39'E, 520–540 m alt., 1996, Krog & Timdal RE48/17.

Chemotype II: **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Lulando Forest at the NE edge of Mufindi escarpment, 8°36'S, 35°37'E, 1450 m alt., 1989, Krog 3T23/18a; – Iringa Distr., Mufindi area, Luhota Dam and Luhota Forest, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T12/5; – Iringa Distr., Mufindi escarpment, 8°40'S, 35°20'E, 1750–1800 m alt., 1989, Krog 4T15/2; – Iringa Distr., Mufindi area, Luisenga, 8°36'S, 35°18'E, 1800 m alt., 1989, Krog 4T16/3, 5; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/26, 27; – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/45, 51; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, lower part, 4°49'S, 38°30'E, 1300–1500 m alt., 1988, Krog 2T12/39.

11. **Phyllopsora halei** (Tuck.) Zahlbr., *Cat. lich. univ.* **4:** 398 (1926).

Thallus consisting of prothallus and small, adnate, isodiametric areolae which are more or less discrete peripherally and form a more or less continuous crust centrally. Prothallus thick, reddish brown. Areolae pale green and glabrous above, paler and pubescent along the margin (at least when discrete). Isidia usually abundant, thick, medium long, usually simple, straight, erect, constricted at the base. Upper cortex of type 2, 30–50 µm thick, containing crystals dissolving in K (PD± yellow, K+ yellow); medulla containing crystals dissolving in K (PD± yellow, K+ yellow).

Apothecia rare, up to 1 mm diam., rounded, simple, weakly to moderately convex, dark brown, with an often darker, glabrous, more or less disappearing margin. Excipulum and hypothecium dark reddish brown; epithecium colourless; no crystals in apothecia (all parts K– or faintly K+ violet). Ascospores narrowly ellipsoid to shortly

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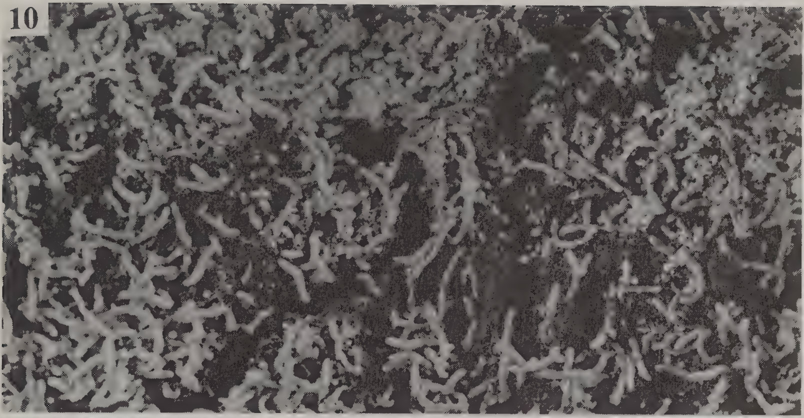

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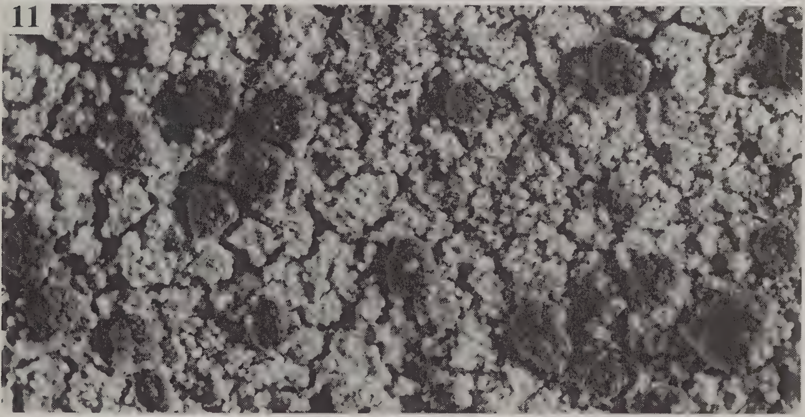

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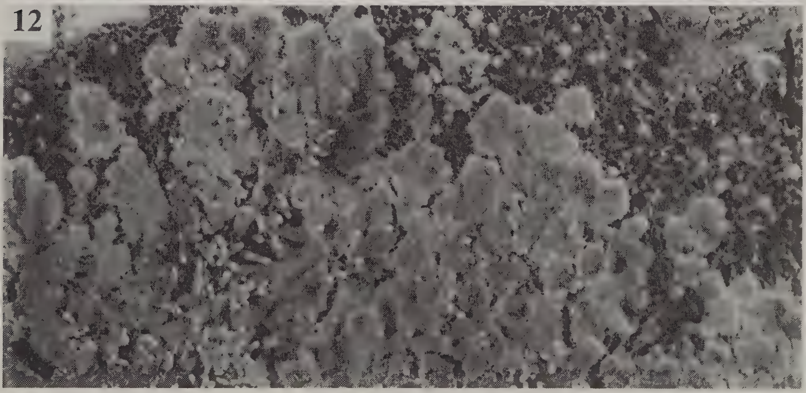

Fig. 10. *Phyllopsora furfuracea*, La Réunion, Krog & Timdal RE40/42, 7.3 ×.
Fig. 11. *Phyllopsora kalbii*, Tanzania, Santesson 21525, 11 ×.
Fig. 12. *Phyllopsora kiiensis*, Tanzania, Santesson 23277, 11 ×.

bacilliform, simple, 9–13.5 × 2.5–4 µm (n=20).

Pycnidia immersed to sessile; pycnoconidia bacilliform, 8–10 × c. 1 µm.

Chemistry: Chemotype I: Atranorin and a series of unknown terpenoids (T3 characterized here). Chemotype II: Atranorin and a series of unknown terpenoids (T1 and T2 characterized here). Chemotype III: Atranorin and unknown compound U1.

African material of this species was by Swinscow & Krog (1981) included in *P. pannosa* Müll. Arg., which was kept separate from the North American *P. halei* by the presence of isidia. Brako (1991) synonymized them, but without description or discussion of the isidia. In our material, the number of isidia varied greatly. They were occasionally absent in parts of a thallus, as also observed by Swinscow & Krog (1981).

The chemical variation within the species was previously unknown, except for a brief mention in Swinscow & Krog (1981: 236) of what is here called chemotype II. We have found the terpenoid pattern of this chemotype to be identical with that of chemotype D of *Toninia* as described by Timdal (1992). An isotype from Louisiana (H-NYL 20522) had the same series of unknown terpenoids as chemotype I from Africa.

Phyllopsora halei has been collected in montane rainforest at 1560–2250 m alt. Swinscow & Krog (1981) recorded the species also from Uganda.

Specimens examined: Chemotype I: **Kenya**, *Central Prov.*, Nyeri Distr., Mt Kenya, bridge where Naro Moru track crosses River Naro Moru, 0°09'S, 37°06'E, 2200 m alt., 1972, Krog K32/143; – Nyeri Distr., Burguret River, 0°07'S, 37°07'E, 2200–2300 m alt., 1976, Krog 4K27/110. **Tanzania,** *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Luhota Dam and Luhota Forest, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T12/2; – Iringa Distr., Mufindi area, 8°35'S, 35°15'E, 1970 m alt., 1989, Krog 4T17/3, 20.

Chemotype II: **Tanzania**, *Eastern Prov.*, Morogoro District, Nguru Mts, 3 km N of Maskati Mission, 1700 m alt., 1988, Pócs 88041/A (EGR); – *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Lugoda tea estate, Kidopi A, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T14/1; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/21; – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/44, 86b. **South Africa**, *Natal*, Kokstad, Weza, in Geli forest near Harding, 1982, Brusse 1846 (O).

Chemotype III: **Ethiopia**, *Sidamo Prov.*, 40 km N of Kebre Mengist, 2250 m alt., 1972, Krog E14/8; – Yirga Alem, Sidamo Provincial Hospital, 1800 m alt., 1972, Krog E20/42.

12. **Phyllopsora kalbii** Brako, *Fl. Neotrop. Monogr.* **55**: 51 (1991). Fig. 11.

Thallus effuse, squamiform, formed by prothallus and granular, isodiametric, adnate areolae which develop into more or less proliferating and ascending squamules. Prothallus thin, but rather well developed, white. Squamules small, pale green, glabrous, often pubescent along the margin. Isidia abundant, globular, difficult to distinguish from budding areolae. Upper cortex of type 2, 15–20 µm thick; algal layer filling the inner part of the squamule; cortex and algal layer not containing crystals (PD–, K–).

Apothecia common, up to 1.5 mm diam., more or less rounded, simple to conglomerate, plane to strongly convex, medium brown, with an indistinct, concolorous, sometimes pubescent margin. Excipulum pale to dark brown; hypothecium dark brown, epithecium pale brown; no crystals in apothecia. Ascospores narrowly ellipsoid to shortly bacilliform, simple, 6–10 × 2–3 µm (n=20).

Pycnidia not seen.

Chemistry: No lichen substances.

In Africa, *P. kalbii* has been collected in montane forests. The two specimens examined by us are listed in the protologue under the examined specimens. Brako (1991) further listed one specimen from Kenya (2050 m alt.) and one from Tanzania (c. 2400 m alt.).

Specimens examined: **Tanzania**, *Northern Prov.*, Arusha Distr., Mt Meru, E slope, road to the crater, Jekukumia River, 3°14'S, 36°48'E, 2100–2200 m alt., 1970, Santesson 21525 (UPS); – Moshi Distr., Mt Kilimanjaro, W slope, Simba Farm, 3°01'S, 37°06'E, c. 1700 m alt., 1970, Santesson 21001a (UPS).

13. Phyllopsora kiiensis (Vainio) Gotth. Schneider, *Biblioth. lichenol.* 13: 177 (1980, '1979'). Fig. 12.

Thallus effuse, squamiform. Prothallus well developed, reddish brown. Squamules medium sized, adnate, isodiametric or slightly elongated, scattered when young, later often contiguous or slightly imbricate, crenulate to incised, plane to weakly convex, medium green, glabrous on the upper side, pubescent along the margin. Isidia usually abundant, attached marginally to the squamules, thin to medium thick, often long, simple to slightly branched. Upper cortex of type 2, 15–30 µm thick, not containing crystals (PD–, K–); medulla containing crystals dissolving in K (PD–, K–).

Apothecia not common, up to 2 mm diam., of irregular shape, usually conglomerate, plane to weakly convex, pale brown, with an indistinct, slightly paler, pubescent margin. Excipulum pale brown to colourless; hypothecium pale brown in lower part, yellowish brown in upper part; epithecium colourless; no crystals in apothecia. Ascospores narrowly ellipsoid to shortly bacilliform, simple, 7.5–9.5 × 2–3 µm (n=15).

Pycnidia not seen.

Chemistry: Furfuracein.

Phyllopsora kiiensis was regarded as a synonym of *P. furfuracea* by Swinscow & Krog (1981, as *P. haemophaea*), and discussed in detail in the general discussion (p. 223). On the basis of more examined material, we now believe that there are two species involved: one with minute areolae which often fuse and form a continuous crust, or areolae lacking and thallus formed by isidia only (*P. furfuracea*), and one with a well developed, squamiform thallus (*P. kiiensis*). *Phyllopsora kiiensis* may also be confused with *P. corallina*, see that species for discussion.

The species was reported as new to Africa by Krog (2000), on the basis of the collections from Tanzania listed below. In Africa, the species has been collected in dry to humid forest and woodland at 280–1750 m alt.

Specimens examined: **Kenya**, *Coast Prov.*, Kwale Distr., Shimba Hills, Makadara Forest, 4°13'S, 39°24'E, c. 300 m alt., 1970, Santesson 20876a (UPS); – Kwale Distr., Shimba Hills, 25 km SW of Mombasa, Kivumoni Forest, 4°12'S, 39°28'E, 280 m alt., 1972, Krog K41/116; – *Western Prov.*, Kakamega Distr., Kakamega Forest, near Yala River 5–7 km S of Forest Station, 0°11'N, 34°52'E, 1500–1700 m alt., 1970, Santesson 21822 (UPS). **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/15; – *Tanga Prov.*, Lushoto Distr., [East] Usambara Mts, Amani, in the surroundings of Forestry House, 5°07'S, 38°38'E, c. 900 m alt., 1971, Santesson 23277, 23291 (UPS).

14. **Phyllopsora longispora** Swinscow & Krog, *Nord. J. Bot.* **5**: 493 (1986, '1985').

The species is known from Kenya, but was not encountered in our material. See Swinscow & Krog (1986) for description and discussion. Brako (1989) excluded the species from the genus. It is only known from the type collection, and we believe more material is needed before a decision can be reached.

15. **Phyllopsora martinii** Swinscow & Krog, *Lichenologist* **13**: 232 (1981). Fig. 13.

Thallus effuse, squamiform. Prothallus well developed, reddish brown. Squamules medium sized, adnate to somewhat ascending, isodiametric, scattered when young, later contiguous or slightly imbricate, crenulate, plane to weakly convex, medium green, glabrous on the upper side, glabrous or faintly pubescent along the margin. Isidia common, attached marginally to the squamules, medium thick, often long, simple to sparingly branched. Upper cortex of type 2, 30–50 µm thick, containing crystals dissolving in K; medulla containing crystals partly dissolving in K (PD+ orange, K–).

Apothecia common, up to 2.5 mm diam., rounded when young, later of irregular shape, simple to conglomerate, plane to strongly convex, pale to medium brown, with an indistinct, concolorous to darker, glabrous margin. Excipulum pale brown to colourless or with patches of reddish brown pigment; hypothecium pale yellowish brown; epithecium colourless; no crystals in apothecia. Ascospores ellipsoid, simple, 5.5–8 × c. 2.5 µm (n=30).

Pycnidia not seen.

Chemistry: Argopsin (major), chlorophyllopsorin (major), and norargopsin (minor).

Phyllopsora martinii is mainly characterized by a squamiform thallus with marginal, cylindrical isidia; presence of argopsin, norargopsin, and chlorophyllopsorin; a thick upper cortex of type 2; pale to medium brown apothecia with a usually darker and glabrous margin; and ellipsoid ascospores. It was regarded as a synonym of *P. corallina* var. *ochroxantha* by Brako (1991); see the discussion under *P. corallina*.

Phyllopsora martinii has been collected in dry, shady woodland and humid submontane forest, at 350–1450 m alt.

Specimens examined: **Kenya**, *Coast Prov.*, Kwale Distr., Shimba Hills, 25 km SW of Mombasa, Kivumoni Forest, 4°12'S, 39°29'E, 350 m alt., 1972, Krog & Swinscow K42/3 (O, isotype). **Tanzania**, *Eastern Prov.*, Morogoro Distr., Magotue Forest Reserve, 450 m alt., 1989, Krog 3T13/6, 7; – *Southern Highlands Prov.*, Iringa Distr., Lulando Forest at the NE edge of Mufindi escarpment, 8°36'S, 35°37'E, 1450 m alt., 1989, Krog 3T23/47.

16. **Phyllopsora mauritiana** (Taylor) Gotth. Schneider, *Biblioth. lichenol.* **13:** 177 (1980, '1979'). Fig. 14.

Thallus forming large circular patches, consisting of prothallus and small, adnate, isodiametric areolae which are discrete to adjoined peripherally and form a cracked to continuous crust centrally. Prothallus thick, reddish brown. Areolae pale green and glabrous above, paler and often pubescent along the margin (at least when discrete). Isidia and lacinules absent. Upper cortex of type 2, 25–45 µm thick, not containing

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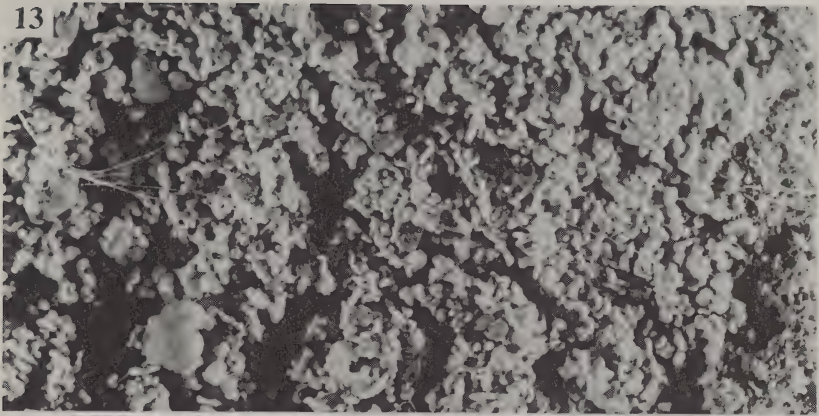

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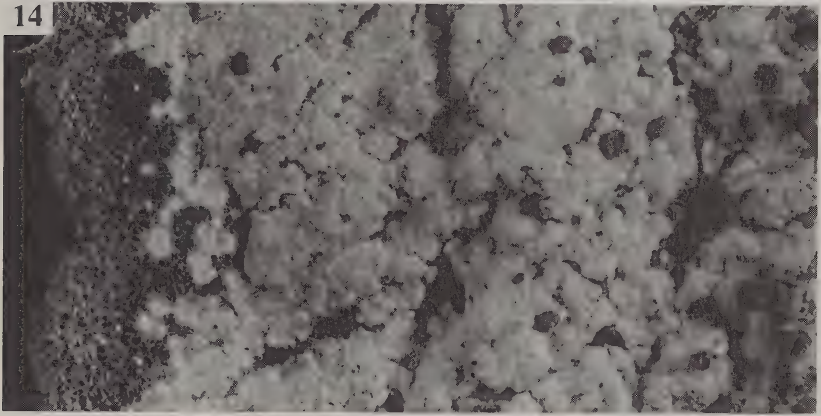

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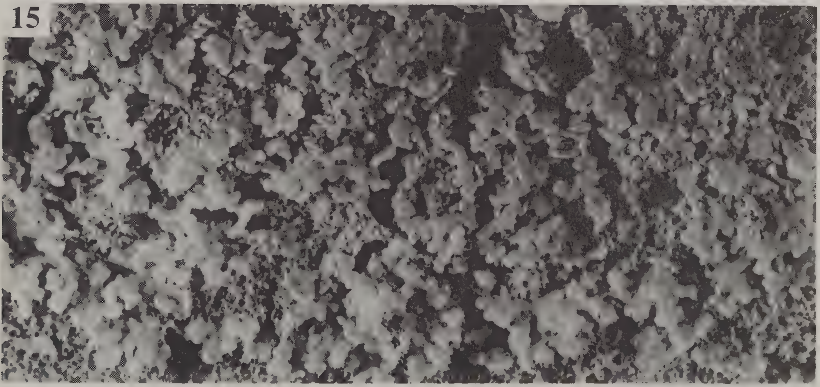

Fig. 13. *Phyllopsora martinii*, Tanzania, Krog 3T13/7, 4.4 ×.

Fig. 14. *Phyllopsora mauritiana*, Mauritius, Krog & Timdal MAU9/43, 5 ×.

Fig. 15. *Phyllopsora mediocris*, Tanzania, Moberg 1481a-1 (holotype), 4.4 ×.

crystals; medulla not containing crystals (PD–, K–).

Apothecia abundant, up to 1 mm diam., rounded, simple to conglomerate, convex, medium brown, with a paler, glabrous, indistinct but usually persistent margin. Excipulum pale brown; hypothecium colourless to pale brown; epithecium colourless; no crystals in apothecia (all parts K–). Ascospores ellipsoid to fusiform, simple, 8.5–10.5 × 3–4 μm (n=30).

Pycnidia more or less sessile; pycnoconidia bacilliform, 6–8 × c. 1 μm.

Chemistry: No lichen substances.

This crustose, non-isidiate and non-lacinulate species may be confused mainly with *P. borbonica*; see that species for discussion.

Phyllopsora mauritiana has been collected in humid submontane forest in Tanzania at 1300–1500 m alt. (Krog 1991), and in humid elfin forest in Mauritius at c. 600 m alt.

Specimens examined: **Tanzania**, *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, lower part, 4°49'S, 38°30'E, 1300–1500 m alt., 1988, Krog 2T12/37. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/43, 44; – Macchabee Forest, along the path to Mt Bris Fer, 20°23'S, 57°26'E, 560–620 m alt., 1991, Krog & Timdal MAU64/26.

17. **Phyllopsora mediocris** Swinscow & Krog, *Lichenologist* **13**: 234 (1981). Fig. 15.

Thallus effuse, squamiform. Prothallus medium thick, reddish brown. Squamules medium sized, medium wide, at first adnate, soon ascending, lacinulate, plane to weakly convex, crenulate to incised, medium green, glabrous to finely pubescent along the margin. Lacinules usually present, simple. Isidia absent. Upper cortex of type 1–2, 25–40 μm thick; upper cortex and medulla not containing crystals (PD–, K–).

Apothecia uncommon, up to 1 mm diam., rounded to irregular, plane to weakly convex, pale to medium brown, with an indistinct, concolorous to paler, finely pubescent margin. Excipulum, hypothecium, and epithecium colourless. Ascospores narrowly ellipsoid or fusiform to bacilliform, simple, 8.5–13.5 × 2.5–3 μm (n=10).

Pycnidia not seen.

Chemistry: No lichen substances.

Phyllopsora mediocris is distinguished from *P. confusa* mainly by its broader, at most incised, but not coralloid squamules and lacinules. Furthermore, the prothallus is thicker and usually more pigmented. The lacinules are sometimes poorly developed, and the squamules merely crenulate. When the lacinules are well developed, the thallus may resemble that of a poorly developed *P. albicans*; that species differs in its secondary chemistry, however.

The species has been collected in montane rainforest and humid woodland, in East Africa at 900–1850 m alt. and in the Mascarenes at 540–1650 m alt.

Specimens examined: **Kenya**, *Northern Frontier Prov.*, Marsabit National Reserve, in the eastern slope close to Marsabit lodge, 2°19'N, 37°58'E, c. 1500 m alt., 1979, Moberg 3761 (UPS 29080). **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Buffalo Hill at edge of Mufindi escarpment, 8°40'S, 35°20'E, 1850–1900 m alt., 1989, Krog 4T10/4; – Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/3, 4, 17a; – *Tanga Prov.*, Lushoto Distr., [East] Usambara Mts, Amani, in the surroundings of Forestry House, 5°07'S, 38°38'E, c. 900 m alt., 1971, Moberg 1481a-1 (UPS 30462, holotype); – Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/23. **Mauritius**, *Plaines Wilhems*, Macchabee Forest, 0.5–1 km ESE of Macchabee kiosk, 20°24'S, 57°26'E, 600 m alt., 1991, Krog & Timdal MAU65/17; – *Savanne*, along the road Bois Chéri-Grand Bassin, at the bridge over Rivière des Anguilles, 20°25'S, 57°30'E, 540 m alt., 1991, Krog & Timdal MAU3/3. **La Réunion**, SSW slope of Piton de la Fournaise volcano, N of Piton Larde, 21°17.5'S, 55°41.2'E, 1650–1850 m alt., 1996, Szabo 9655/CS (EGR).

18. Phyllopsora nemoralis Timdal & Krog, n. sp. Fig. 16.

Thallus crustaceus. Isidia vulgaria. Cortex crassiusculus, typo 1–2. Apothecia rara, ad 2.5 mm lata, brunnea. Hypothecium pallide brunneolum vel incoloratum. Sporae anguste ellipsoideae, simplices, 7.5–12.5 × 2.5–3 µm. Thallus argopsinum et atranorinum continens.

Type: La Réunion, Forêt de Bélouve, track from Gite de Bélouve to viewpoint, 21°03'S, 55°32'E, 1500–1550 m alt., 1996, Krog & Timdal RE25/32 (O, holotype).

Thallus effuse, crustose, areolate when young, later consisting mainly of isidia. Prothallus poorly developed, white to reddish brown. Areolae small, crenulate, pale green to medium green, glabrous or slightly pubescent when young, not clearly distinct from isidia. Isidia numerous, thin, short, simple or rarely branched. Upper cortex of type 1–2, 15–25 µm thick, containing crystals dissolving in K (PD+ orange, K–); algal layer filling the inner part of the areolae and isidia; no or few crystals in algal layer.

Apothecia rare, up to 2.5 mm diam., rounded to irregular, simple, weakly convex, medium brown, with an indistinct, concolorous or paler margin. Excipulum, hypothecium, and epithecium pale brown to colourless. Ascospores narrowly ellipsoid or fusiform to shortly bacilliform, simple, 7.5–12.5 × 2.5–3 µm (n=30).

Pycnidia not seen.

Chemistry: Argopsin (major) and atranorin (minor).

Phyllopsora nemoralis is distinguished by its crustose thallus; thin, short, mainly simple isidia; pale brown to colourless hypothecium; and the presence of argopsin. *Phyllopsora furfuracea* differs mainly in forming more richly branched isidia; having a darker, partly reddish brown hypothecium; and containing furfuracein or being acid deficient (sometimes with traces of atranorin). The European species *P. rosei* differs in being non-isidiate, having a persistently white prothallus, and lacking atranorin. *Phyllopsora malcolmii* was said to be squamulose and to possibly contain low concentrations of argopsin (Vězda & Kalb *in* Vězda 1995). We found the species to be crustose and did not detect any traces of argopsin by TLC. In addition to the chemical difference, it differs from *P. nemoralis* in being non-isidiate, having a persistently white prothallus, and bacilliform ascospores, 13–18 × 2–2.2 µm according to Vězda & Kalb *in* Vězda (1995).

Phyllopsora nemoralis has been collected in well lit sites in woodland, in Tanzania at 1750–1800 m alt. and in La Réunion at 1550–2010 m alt.

Specimens examined: **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Mufindi escarpment, 8°40'S, 35°20'E, 1750–1800 m alt., 1989, Krog 4T15/3. **La Réunion**, along road towards Piton de la Fournaise, 1 km below Nez de Boeuf, 21°12'S, 55°37'E, 2010 m alt., 1996, Krog & Timdal RE13/11; – Forêt de Bélouve, track from Gite de Bélouve to viewpoint, 21°03'S, 55°32'E, 1500–1550 m alt., 1996, Krog & Timdal RE25/32 (holotype). **South Africa**, *Cape Province*, Western Cape, Caledon, Riviersonderend Berge, Oubos forest, 34°04'S, 19°50'E, 600 m alt., 1996, Moberg 11774 (UPS 155652).

19. Phyllopsora subhispidula (Nyl.) Kalb & Elix, *Biblioth. lichenol.* **57**: 293 (1995). Fig. 17.

Thallus squamiform, effuse to forming circular thalli with radiating marginal squamules. Prothallus usually developed on the underside of the squamules but not extending beyond the margin, reddish brown. Squamules large, adnate or slightly ascending near the tip, elongated, contiguous to partly imbricate, incised to deeply divided, plane to weakly convex; upper side pale green to medium green, glabrous in inner part and distinctly pruinose towards the lobe-ends; margin pale, pubescent. Isidia numerous in the inner part of the thallus, marginal on the squamules, thick, long, simple. Upper cortex of type 1, 50–80 µm thick, containing crystals dissolving in K (PD–, K–); medulla containing crystals dissolving in K (PD+ orange, K–) and sometimes calcium oxalate.

Apothecia not common, up to 1 mm diam., rounded, simple or often becoming conglomerate, convex and immarginate even when young, reddish brown. Excipulum and hypothecium pale brown to colourless; epithecium medium brown. No crystals in apothecia. Ascospores ellipsoid to fusiform, simple, 6.5–11 × 2.5–4 µm (n=20).

Pycnidia not seen.

Chemistry: Argopsin (major), zeorin (major), norargopsin (minor), and atranorin (trace).

East African specimens were included with some hesitation in *P. santensis* (Tuck.) Swinscow & Krog by Swinscow & Krog (1981). The type of this name is from North America and Swinscow & Krog (1981) noted that African material was more pubescent and pruinose than the type, and that the type lacked zeorin and the trace of atranorin which occurred in the African material. Brako (1991) regarded *P. santensis* as a variety of *P. corallina*. According to Brako (1991), *P. corallina* is glabrous. It appears that two taxa may be involved: one pruinose species similar to *P. buettneri* but differing in producing isidia and in chemical characters, and one epruinose species similar to *P. corallina*. The former was named *P. subhispidula* (Nyl.) Kalb & Elix by Kalb & Elix (1995), who regarded *P. buettneri* var. *glauca* (B. de Lesd.) Brako as synonymous with it. The type material in H-NYL (No 30812) is a fragment without isidia or lacinules. It is distinctly pruinose, and the interpretation must be based on its chemistry which Kalb & Elix (1995) reported as being argopsin, norargopsin and zeorin.

Phyllopsora subhispidula has been collected in montane rainforest and humid woodland, in Tanzania at 1550–1850 m alt. and in La Réunion at c. 1400 m alt. Swinscow & Krog (1981, as *P. santensis*) recorded the species also from Kenya and Uganda.

Specimens examined: **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Mufindi escarpment, 8°40'S, 35°20'E, 1750–1800 m alt., 1989, Krog 4T15/7, 8; – Iringa Distr., Mufindi area, Luisenga, 8°36'S, 35°18'E, 1800 m alt., 1989, Krog 4T16/6; – *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/24; – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/48, 49; – Lushoto Distr., West Usambara Mts, Mazumbai University Forest Reserve, Sagara Ridge, 4°49'S, 38°30'E, 1850–1980 m alt., 1988, Krog 2T9/50; – Lushoto Distr., West Usambara Mts, Kwagoroto Summit WNW of Mazumbai village, 4°48'S, 38°29'E, 1850–1950 m alt., 1988, Krog 2T10/38. **La Réunion**, Ins. Borbonia, Lepervanche-Mézières 73 (H-NYL 30812, coll. orig.); – Cirque de Cilaos, along road towards Bras Sec, Forêt de la Mare á Joseph, 21°07'S, 55°30'E, 1390 m alt., 1996, Krog & Timdal RE36/15; – Col de Bébour, along track towards Plaine des Cafres, 21°07'S, 55°34'E, 1420–1600 m alt., 1996, Krog & Timdal RE40/46.

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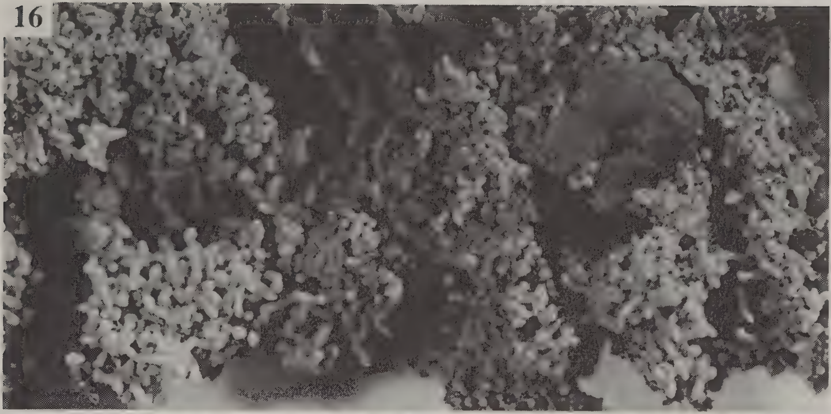

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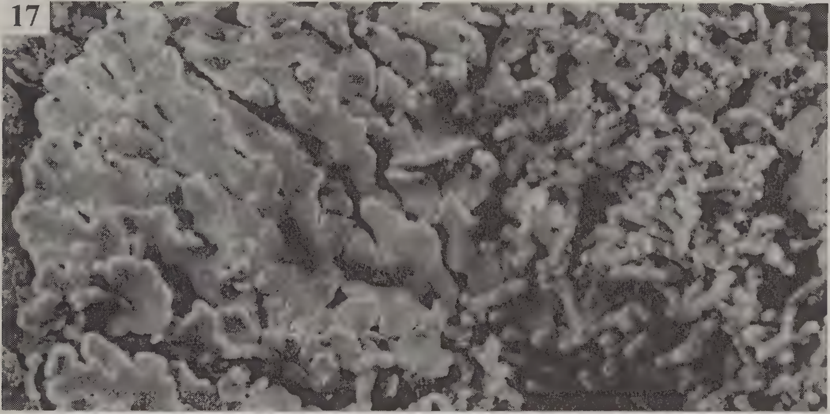

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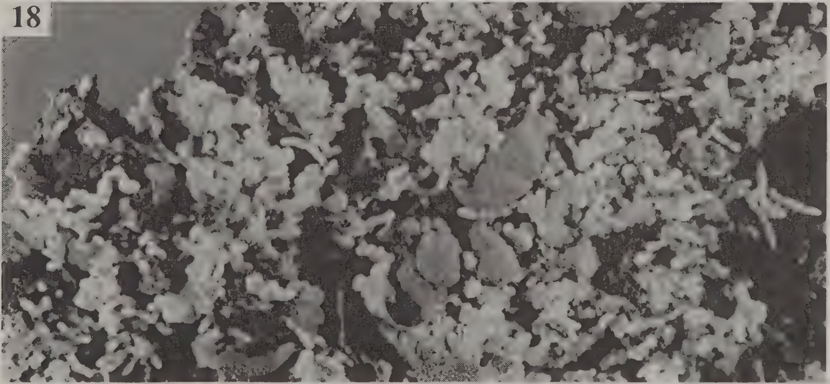

Fig. 16. *Phyllopsora nemoralis*, La Réunion, Krog & Timdal RE25/32 (holotype), 8 ×.
Fig. 17. *Phyllopsora subhispidula*, La Réunion, Krog & Timdal RE36/15, 6.6 ×.
Fig. 18. *Phyllopsora swinscowii*, Mauritius, Krog & Timdal MAU9/50 (holotype), 6.6 ×.

20. Phyllopsora swinscowii Timdal & Krog, **n. sp.** Fig. 18.

Thallus squamiformis. Squamulae mediocres, adnatae vel plus minusve ascendentes, isodiametrae vel elongatae. Isidia vulgaria, marginalia. Cortex crassiusculus, typo 1–2. Apothecia ad 1.5 mm lata, brunnea. Hypothecium incoloratum. Sporae anguste ellipsoideae, simplices, 6.5–9.5 × c. 2–2.5 μm. Thallus methyl 2,7-dichloropsoromatum et methyl 2,7-dichloronorpsoromatum continens.

Type: Mauritius, Black River, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/50 (O, holotype).

Thallus effuse, squamiform. Prothallus well developed, reddish brown. Squamules medium sized, adnate to somewhat ascending, isodiametric to elongated, scattered when young, later often contiguous or imbricate, crenulate to incised, plane to weakly convex, medium green, glabrous on the upper side, usually faintly pubescent along the margin. Isidia common, attached marginally to the squamules, thin to medium thick, often long, simple to slightly branched. Upper cortex of type 1–2, 20–40 μm thick, containing crystals dissolving in K; medulla containing crystals partly dissolving in K (PD+ orange, K–).

Apothecia common, up to 1.5 mm diam., rounded when young, later of irregular shape, mainly simple, plane to strongly convex, medium to dark brown, with an indistinct, concolorous, glabrous to pubescent margin. Excipulum pale brown to colourless; hypothecium colourless; epithecium colourless; no crystals in apothecia. Ascospores narrowly ellipsoid, simple, 6.5–9.5 × c. 2–2.5 μm (n=20).

Pycnidia not seen.

Chemistry: Methyl 2,7-dichloropsoromate (major) and methyl 2,7-dichloronorpsoromate (major).

Phyllopsora swinscowii is mainly characterized by a squamiform thallus with marginal, cylindrical isidia; presence of methyl 2,7-dichloropsoromate and methyl 2,7-dichloronorpsoromate; a medium thick upper cortex of type 1–2; medium to dark brown apothecia with a concolorous, glabrous to pubescent margin; and narrowly ellipsoid ascospores. Swinscow & Krog (1981: 215–217, 233) examined a specimen (Santesson 20867a) of this taxon; they did not assign it to any species, but compared it with *P. martinii*. Our additional material confirms that the squamules and isidia are more delicate and the ascospores slightly longer than in *P. martinii*. The upper cortex is composed of hyphae with more angular lumina. *Phyllopsora swinscowii* may be confused with *P. corallina* or *P. africana*; see *P. corallina* for discussions.

Phyllopsora swinscowii has been collected in dry to humid woodland and montane forest, in East Africa at 300–1900 m alt. and in Mauritius at 580–730 m alt. It is highly probable that the specimen 'Brako 7460' from Ecuador, from which Elix et al. (1990) isolated methyl 2,7-dichloropsoromate and methyl 2,7-dichloronorpsoromate, belongs in this species.

Specimens examined: **Kenya**, *Coast Prov.*, Kwale Distr., Shimba Hills, Makadara Forest, 4°13'S, 39°24'E, c. 300 m alt., 1970, Santesson 20867a, 20894 (UPS). **Tanzania**, *Southern Highlands Prov.*, Iringa Distr., Mufindi area, Luhota Dam and Luhota Forest, 8°35'S, 35°15'E, 1900 m alt., 1989, Krog 4T12/17; – Iringa Distr., Mufindi area, Kivere Forest Reserve, escarpment edge, 8°39'S, 35°14'E, 1750–1800 m alt., 1989, Krog 4T23/48; – Iringa Distr., Mufindi area, Kigogo forest, 8°40'S, 35°15'E, 1800–1850 m alt., 1989, Krog 4T25/32;

– *Tanga Prov.*, Lushoto Distr., West Usambara Mts, Gonja Mt. 5 km E of Mgwashi village, 4°46'S, 38°33'E, 1600–1700 m alt., 1988, Krog 2T6/25; – Lushoto Distr., West Usambara Mts, along motor road from Mazumbai University Forest Station to the edge of the forest reserve, 4°48'S, 38°30'E, 1500–1560 m alt., 1988, Krog 2T8/50. **Mauritius**, *Black River*, along the path from Plaine Champagne towards Piton de la Petite Rivière Noire, 20°25'S, 57°25'E, 600 m alt., 1991, Krog & Timdal MAU9/50 (holotype); – *Moka*, Mt Le Pouce, 20°12'S, 57°31'E, 730–750 m alt., 1991, Krog & Timdal MAU47/15; – *Savanne*, along the road between Mt Cocotte and Bassin Blanc, 20°26'S, 57°28'E, 550–580 m alt., 1991, Krog & Timdal MAU58/28.

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MYCOTAXON

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UROCYSTIS BEIJINGENSIS SP. NOV. AND A SMUT SPECIES OF UROCYSTIS NEW TO CHINA

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ABSTRACT *Urocystis beijingensis* L. Guo is proposed as a new species and *Urocystis agropyri-campestris* (Massenot) H. Zogg is new to China.

摘要 本文报道 1 个新种，北京条黑粉菌（*Urocystis beijingensis* L. Guo）和 1 个中国新记录种，冰草大孢条黑粉菌[*Urocystis agropyri-campestris* (Massenot) H. Zogg]。

KEY WORDS *Urocystis beijingensis*, *Urocystis agropyri-campestris*, Smut fungi, New species, New record, China

Urocystis beijingensis L. Guo, **sp. nov**. Fig. 1

Sori in foliis strias, primo epidermide obtectas. Massa sporarum atrobrunnea, pulverulenta. Glomeruli sporarum subglobosae, ellipticae, ovoideae vel irregulares, e ustilosporis 1-5 (-6) constructi, cellulis sterilibus omnino circumdati, 23-46(-52)×16.5-33 μm. Ustilosporae subglobosae, ovoideae vel ellipticae, 13.5-20×10.5-15 μm, rufobrunneae; pariete ca 1.5 μm, leves. Cellulae steriles subglobosae vel ellipticae, 7-12.5×5-7.5 μm, pallide flavidobrunneae; pariete sub LM levi, sub SEM verruculoso.

Sori in leaves forming long or short striae, at first covered by the epidermis. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal. ovoid or irregular, 23-46(-52)×16.5-33 μm, composed of 1-5 (-6) ustilospores completely surrounded by sterile cells. Ustilospores subglobose, ovoid or ellipsoidal, 13.5-20×10.5-15 μm, reddish-brown; wall ca 1.5 μm, smooth. Sterile cells subglobose or ellipsoidal, 7-12.5×5-7.5 μm, pale yellowish-brown, smooth in LM, verruculose in SEM.

On *Hierochloa glabra* Trin., Beijing: Songshan, June 13, 1986, L. Guo 733, HMAS 80547 (holotypus).

Urocystis hierochloae (Murashk.) Vánky is similar to *Urocystis beijingensis* L. Guo from which it differs in the smaller spore balls (20-35×15-25 μm) which are

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composed of less ustilospores [1-4(-5), Vánky 1994]. Previously, only the former species on *Hierochloa* was reported from China (Guo & Xi 1989).

During the mycological expedition to the region of Xinjiang in 1986, a number of smut fungi new to China were discovered (Guo & Xi 1989). In addition, the following smut species is new to China:

Urocystis agropyri-campestris (Massenot) H. Zogg Fig. 2

Sori in leaves forming long striae, at first covered by the epidermis. Spore mass blackish-brown, powdery. Spore balls subglobose, ellipsoidal, ovoid or slightly irregular, (16-)25-40×(15-)20-33 μm, composed of 1-4(-5) ustilospores completely surrounded by sterile cells. Ustilospores subglobose, ovoid, ellipsoidal or slightly irregular, 15-22.5×10-16.5 μm, reddish-brown, smooth; wall ca 1 μm. Sterile cells ovoid or ellipsoidal, 5.5-13.5×5-7.5 μm, pale yellowish-brown, smooth in LM and verruculose in SEM.

On *Leymus chinensis* (Trin.) Tzvel, Xinjiang: Kuytun, July 29, 1986, L. Guo 970, HMAS 79212.

This species has larger ustilospores than *Urocystis agropyri* (Vánky 1994).

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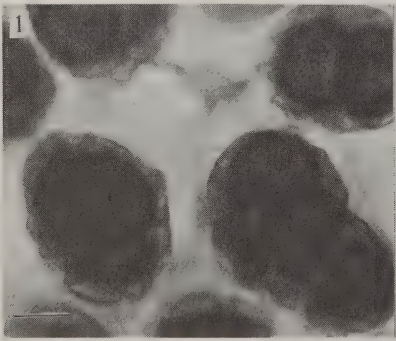

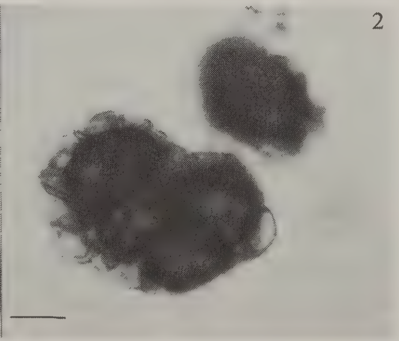

Fig. 1. *Urocystis beijingensis* on *Hierochloa glabra* (HMAS 80547, holotypus) bar = 11μm

Fig. 2. *Urocystis agropyri-campestris* on *Leymus chinensis* (HMAS 79212) bar = 11μm

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A NEW SPECIES AND NEW RECORDS OF POLYPORE FUNGI FROM THE PATAGONIAN ANDES FORESTS OF ARGENTINA

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Summary

Skeletocutis nothofagi sp. nov. is described based on a combination of hyphal features, the generative hyphae having irregularly thickened walls with typical incrustation of the *Skeletocutis*-type, suballantoid spores, and hymenial cystidioles. *Gloeoporus dichrous*, *Cyclomyces tabacinus*, *Grifola gargal*, *Postia balsamea* and *Rigidoporus eminens* are newly recorded from the studied area.

Key words: Aphyllophorales, Hymenochaetaceae, *Nothofagus,* Polyporaceae, *Skeletocutis*

Introduction

The polypore flora (Aphyllophorales, Basidiomycota) of the southern forests of Argentina, largelydominated by *Nothofagus* spp. over most of their range, has attracted the attention of several workers (*e.g*., Wright & Deschamps 1972, Hjortstam & Ryvarden 1985, Rajchenberg 1989). The regular search of polypores by this author during recent years has yielded new records and/or new taxa almost every year. Though this is a somewhat disturbing fact for a mycota whose more frequent components were already described almost 30 years ago by Wright & Deschamps (1972, 1975), this should not be a surprise. The area is characterized by a long but narrow strip of forest in the continent, *ca*. 30-80 kms. wide, that only broadens in the island of Tierra del Fuego. It contains a diversity of forest types, covering about 3,015,000 ha, that range from 4000 mm to 500 mm precipitation from W to E, and that have been summarized by Cabrera (1971) and Hueck (1978). The continental weather with a rather short collecting season also restrains the possibilities of regularly finding certain species. All the records based on single collections (Hjortstam & Ryvarden 1985, Rajchenberg 1993, 1995; Rajchenberg & Greslebin 1998) have, nevertheless, been confirmed with new ones.

The aim of this work is to give an account of several species recently recognized from the area, including the description of a new species in the genus *Skeletocutis* Kotl. & Pouzar.

MATERIALS AND METHODS

Microscopic examination of basidiocarps was made from freehand sections mounted in 5% KOH with aqueous phloxine, Melzer's reagent, cresyl-blue and cotton blue. All collections are kept at the author's address unless otherwise stated (*cfr*. Holmgren *et al.* 1990). Authors of the species are cited according to Kirk & Ansell (1992).

RESULTS

Skeletocutis nothofagi Rajchenb. *sp. nov.* Fig. 1-5

Basidiocarpo annuo, resupinato, pori 2.5-4 mm^{-1}, cremei, tubi leviter ochracei. Systema hypharum monomiticum; hyphae generatoriae fibulatae, tenues vel irregulariter crassitunicatae. Basidiosporis suballantoides, breviter cylindraceis et leviter arcuateis, 4.5-5.5 x 1.7-2 µm. Basidiis claviformibus 13-20 x 4-5 µm. Ligno putrescente albo consociata. Holotypus BAFC 50397.

Holotype: ARGENTINA, Tierra del Fuego, Departamento Ushuaia, Estancia Moat, on fallen branch of *Nothofagus betuloides* ('guindo'), leg. A. Greslebin, 28.Apr.1999 (BAFC 50397).

Basidiocarp annual, lignicolous, resupinate, first as small, roundish bodies that may coalesce, growing up to 10 x 3 x 0.5 cm, with the margins attached to the substrate but slightly separating upon drying. Hymenial surface with pores white-cream, tubes becoming slightly ochraceous upon drying. Margin sterile, cream, felty under the lens, 1-2 mm wide. Pores circular to subgyrose, variable in size in different portions of the basidiocarp, 2.5-4/mm. Context very thin, up to 0.5 mm thick. Tubes up to 5 mm long, dissepiments slight ochraceous. Consistency woody and waxy, especially in the tubes. Rhizomorphs absent.

Hyphal system monomitic, with clamped generative hyphae. Hyphae in the context 3.5-5 µm diam., branched, with homogeneously or irregularly thickened, hyaline walls, leaving or not a central lumen of varying dimension, some hyphae with slightly thickened walls, all hyphae strongly intermingled; conical, sharply-pointed crystals abundantly present on many hyphae; the hyphae immediately adjacent to the substrate are either totally sclerified or irregularly thickened, sometimes forming fascicles or tufts. Dissepiments with similar hyphae but wall thickening homogenous in most of them, with their lumen visible, sclerified generative hyphae rarely present; hyphae 2-3 µm diam., thin-walled, mostly devoid of cytoplasm, with or without incrustations, some with lateral, short and sclerified branches, also present. Subhymenial hyphae mostly thin-walled, with few segments sclerified or with irregularly thickened walls. Pore mouths with hyphae 2-3.5 µm diam., with thin to slightly thickened walls, incrusted or not. All hyphae without a metachromatic reaction but covered by an amorphous substance with a positive reaction in cresyl-blue.

Basidia claviform, 13-20 x 4-5 µm with 4 sterigmata up to 4 µm long.

Basidiospores suballantoid, short-cylindric and slightly curved, 4.5-5.5 x 1.7-2 µm, hyaline, with or without several small guttulae in the cytoplasm, IKI -, acyanophilous.

Cystidia absent but **cystidioles** present, fusoid to mammiform, 12-18 x 3-5 µm.

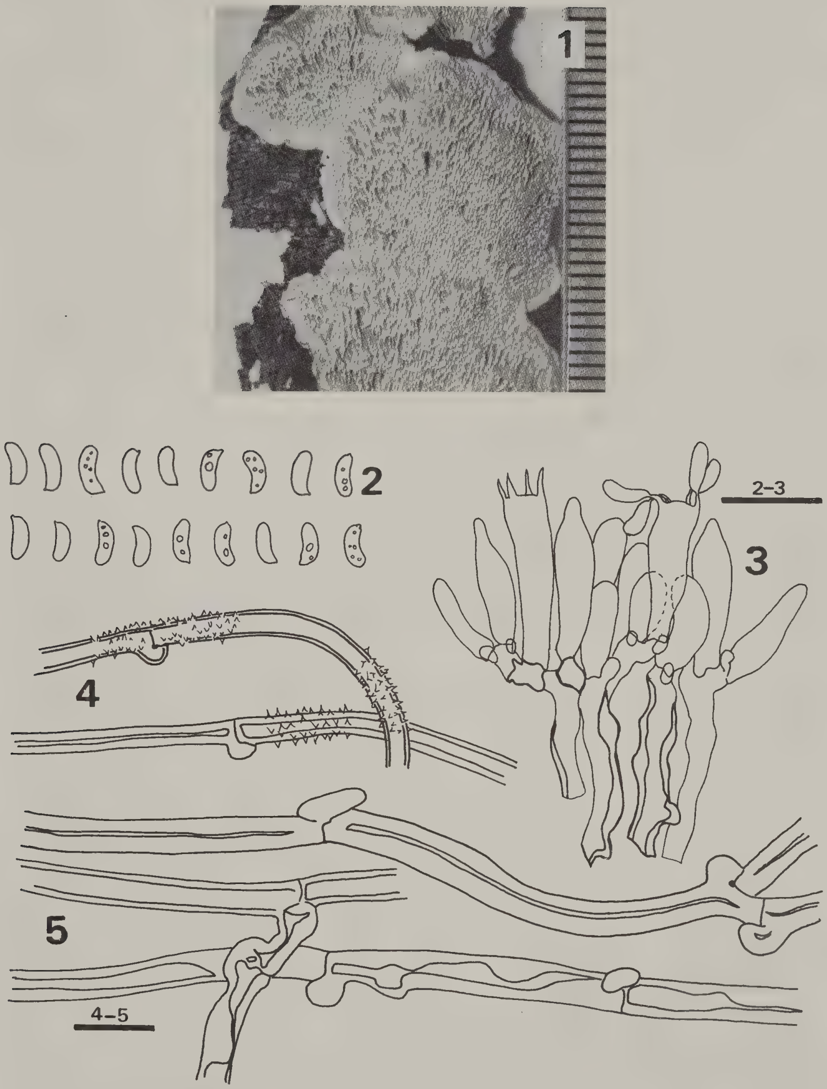

Fig. 1-5. *Skeletocutis nothofagi sp. nov.* (BAFC 50397). 1, Basidiocarp. 2, Basidiospores. 3, Hymenium with basidia and cystidioles; subhymenium with sclerified areas. 4, Incrusted generative hyphae of the context. 5, Sclerified hyphae of the context. Scale in mm (Fig. 1). Bars= 10µm (Fig. 2-5).

All the hymenial structures become sclerified upon maturation, except the spores.
Hyphal pegs present, but scant.
Associated wood-rot white.

Remarks: *Skeletocutis nothofagi* is characterized by a monomitic hyphal system but the abundant sclerified generative hyphae may confuse the picture; nevertheless, dissection of the tissue shows clamp connections in all the hyphal types. Immature basidiospores are ellipsoid to short-cylindric but not slightly curved. The combination of hyphal and spore features and the presence of typical incrustations on the hyphae, together with other basidiocarp characters, warrant the description of the new taxon. This is the third species of *Skeletocutis* known from the studied area. *Skeletocutis stramenticus* (G. Cunn.) Rajchenb. (Rajchenberg 1987, 1995) differs in having a resupinate basidiocarp that develops from a central point and easily detaches from the substrate, hygrophanus, waxy and friable tubes, pores 4-5 /mm and ellipsoid basidiospores 4-5 x 2-2.5 µm. *Skeletocutis portcrosensis* A. David differs in having much thinner basidiocarps that are coposed of thin-walled generative hyphae, with allantoid basidiospores 3.5-4 x 1.5-1.8 µm (Rajchenberg 1993). Other species in the genus that have similar basidiospores differ by the following features (*cfr*. David 1982, Niemelä 1998, Dai 1998, Ryvarden & Gilbertson 1994): *Skeletocutis papyracea* A. David has a dimitic basidiocarp with metachromatic skeletal hyphae that dissolve in 5% KOH. *Skeletocutis amorpha* (Fr.) Kotl. & Pouzar has an effused-reflexed basidiocarp with a well developed monomitic context, dimitic dissepiments and greyish white to yellowish pink hymenial surface.

Though monomitic in structure, *S. nothofagi* has features that clearly point to *Skeletocutis*: typical hyphal incrustation (Keller 1979), irregularly thickened walls of the generative hyphae (*cfr*. David 1982, for several species including *S. amorpha*, the genus type species), presence of short and sclerified branches of the generative hyphae, and fusoid cystidioles in the hymenium. The inclusion of monomitic species of *Skeletocutis* in *Ceriporiopsis* Domanski, as proposed by Ryvarden & Gilbertson (1994), only adds confusion to a genus that already is very variable when anatomical features of basidiocarps, cultural characters and nuclear behavioral features of mycelia of different species are also taken into consideration. If separation of monomitic species of *Skeletocutis* is preferred, they should better be placed in *Tyromyces* P. Karst. Yao *et al*. (1999) have recently shown, on the basis of sequences of ITS (nrDNA), that several *Skeletocutis* species merge with the type species of *Tyromyces*, *T. chioneus* (Fr.) P. Karst., indicating a strong link between both genera. This is also strongly suggested by the works of David (1980, 1982) and David & Duhem (1986). *Tyromyces* does not have, however, the *Skeletocutis*-type of hyphal incrustation in basidiocarps, but this incrustation is produced in culture.

NEW RECORDS

Cyclomyces tabacinus (Mont.) Pat., Essai Tax. p. 98, 1900.
=*Polyporus tabacinus* Mont., Ann. Sci. Nat. Ser. 3, 3: 349.
Material studied: ARGENTINA, Chubut, Parque Nacional Los Alerces, Río Arrayanes, near the Ranger's house, on roots and collar of fallen, much decayed *Nothofagus dombeyi* trunk, leg. M. Rajchenberg 11946, 8.Oct.1999.
Remarks: A pantropical species previously reported from S Chile (Rajchenberg 1989).

Gloeoporus dichrous (Fr.: Fr.) Bres., Hedwigia 53: 75, 1912.
= *Polyporus dichrous* Fr.: Fr., Syst. Mycol. 1: 364, 1821. Observ. Mycol.1: 125, 1815.
Material studied: ARGENTINA, Neuquén, Parque Nacional Nahul Huapi, Los Cántaros, on fallen branch of *N. dombeyi*, leg. M. Rajchenberg 11901, 8.May.1999.
Remarks: A cosmopolitan species not yet recorded from the area but known from other regions in Argentina (Wright & Deschamps 1977).

Grifola gargal Singer, Mycoflora Australis p. 381, 1969.
Material studied: ARGENTINA, Neuquén, Parque Nacional Lanín, Lago Lácar, margin S, road to Lago Queñi, leg. M. Rajchenberg 11107, 11109 and 11112, 28.Apr.1996. Ibid., in *Nothofagus obliqua* forest *ca.* 1 km before Lago Queñi, leg. H. Mattes (MR 11911), 19.May.1999. CHILE, Valdivia, 15 km NE of El Mirador, Cordillera Pelada, 6.May.1967, leg. Miranda, comm. R. Singer M6934 (SGO 092561, holotype).
Remarks: The species was only known from the original description and holotype (Singer 1969). It fruits rather commonly in the northern area of the Patagonian Andes in *Nothofagus obliqua* and *N. nervosa* forests where it is gathered by native and local people for its edibility. A full account of this fungus is in preparation.

Postia balsamea (Peck) Jülich, Persoonia 11: 423, 1982.
=*Polyporus balsameus* Peck, N.Y. State Mus. Ann. Rept. 30: 46, 1878.
Material studied: ARGENTINA, Río Negro, Departamento Bariloche, Río Azul, along the W margin of the river in front of Los Alerces camping area, on stump, leg. M. Rajchenberg, 15.Jun.1998. Parque Nacional Nahuel Haüpi, Puerto Blest, track along the stream Los Clavos, on fallen trunk of *Saxegothaea conspicua*, leg. M. Rajchenberg 11875, 6.May.1999. Neuquén, Parque Nacional Nahuel Huapi, Los Cántaros, 3rd balcony, on standing *S. conspicua* fruiting on a wound in the stem *ca.* 4 m high, leg. M. Rajchenberg 11909, 8.May.1999. CHILE, Valdivia, Osorno, Cordillera Pelada, Chivería, on living trunk of *Saxegothaea*, leg. R. Singer M5709, 10.May.1959 (BAFC 22447).
Reference material: EX URSS, Primorski, Chugujevski, Buliga-Fadejevo, Kljuch Pravaja, Sokolovka, on rotten trunk of *Pinus koraiensis*, leg. & det. E. Parmasto, 5.Aug.1981 (ex TAA 103727).
Remarks: The species is microscopicaly very similar to *Postia dissecta* (Lév.) Rajchenb. in hyphal features and basidiospore morphology (Ryvarden 1981 sub *Tyromyces*, Rajchenberg 1983 sub *Tyromyces floriformis* (Quél.) Bondartsev & Singer). It differs in the greyish and somewhat crenulate pilear surface (totally

creamish white to brownish and zonate in *P. dissecta*) and in the presence of apically incrusted cystidia (cystidia lacking in *P. dissecta*). The incrusted cystidia may be absent in some sections of *P. balsamea* and then overlooked from the specimen.

Rigidoporus crocatus (Pat.) Ryvarden, Occ. Papers Farlow Herb. 118: 13, 1983.
=*Poria crocata* Pat., Jour. Bot. 8: 220, 1894. =*Polyporus (Resupinatus) stillicidiorum* Speg., Bol. Acad. Nac. Cienc. Córdoba 11(2): 165, 1887. *Poria stillicidiorum* (Speg.) Speg. in Sacc., Syll. Fung. 6: 295, 1888.
Material studied: ARGENTINA, Chubut, Parque Nacional Los Alerces, Lago Menéndez, 'alerzal', on fallen trunk of *Nothofagus dombeyi*, leg. M. Rajchenberg 10732, 15.Mar.1993. Neuquén, Parque Nacional Lanín, Lago Lolog, margin N, on fallen branch of *N. dombeyi*, leg. M. Rajchenberg 10695 and P.P. Cwielong, 13.Apr.1992. Lago Queñi, on fallen trunk, leg. M. Rajchenberg 11916, 19.May.1999. Río Negro, Parque Nacional Nahuel Huapi, Lago Frías, road to Puerto Blest, leg. M. Rajchenberg 11891, 7.May.1999. Tierra del Fuego, Depto. Ushuaia, *ca*. Laguna Aguas Blancas, on fallen branch of *N. pumilio*, leg. M. Rajchenberg 10896, 8-10.Dec.1994. Lago Escondido, 60 kms N of Ushuaia, leg. L. Ryvarden 19363, on *Nothofagus* sp., 21.Feb.82 (LPS, O). Río Moat, on fallen branch of *N. betuloides* in mixed forest of *N. betuloides* and *Drymis winteri*, leg. M. Rajchenberg 11512, 26.Mar.1998. Isla de los Estados, leg. C. Spegazzini Mar.1882 (LPS 25550, holotype of *Polyporus stillicidiorum* Speg.). Parque Nacional Tierra del Fuego, Río Pipo, in mixed forest of *N. pumilio* and *N. betuloides*, on fallen, much decayed trunk, leg. M. Rajchenberg 11789, 7.Nov.1998. CHILE, Provincia Palena, ca. bridge on river Futaleufú, on fallen branch, leg. M. Rajchenberg 11076, 5.Apr.1996.
Reference material: ESTONIA, Pärnumaa, Saarde Distr., Viisireiu, on *Alnus glutinosa* big, fallen trunk, leg. T. Niemelä 6012 et al., 17.Jul.1996 (H). GERMANY, Berlin, Palm House in Botanical Garden, leg. P. Magnus, 25.Oct.1879 (H). CHINA, Jilin Prov., Antu Co., Changbaishan For. Res., on rotten wood of *Pinus*, mixed forest, alt. 1000 m, leg. & det. Y.C. Dai, 5.Sep.1993 (H).
Remarks: This is the correct name for material that was erroneously recorded as *Rigidoporus undatus* (Hjortstam & Ryvarden 1985) and *R. vitreus* (Pers.: Fr.) Donk (Rajchenberg & Wright 1987) from southern Argentina.

Rigidoporus eminens Y.C. Dai, Ann. Bot. Fennici 35: 144, 1998.
Material studied: **Argentina**, Neuquén, Parque Nacional Lanín, Lago Queñi, on fallen trunk of *Nothofagus* sp., leg. M. Rajchenberg 11918 and 11919, 19.May.1999. Pehuenia, Lake Moquehe, Pulmarí *ca*. 3 km of stream Quillehue, on fallen and much decayed trunk of *Araucaria araucana* in mixed forest of *A. araucana* and *N. pumilio*, leg. M. Rajchenberg 12035, 10.May.2000
Reference material: CHINA, Jilin Prov., Huadin Co., Dongxing, on rotten wood of *Juglans*, broadleaf forest, leg. & det. Y.C. Dai 1546, 17.Oct.1993 (H).
Remarks: The species has been recently described from NE China (Dai 1998) and from Japan (Núñez & Ryvarden 1999).

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MYCOTAXON

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THE LICHEN FAMILY PHYSCIACEAE (ASCOMYCOTA) IN CHINA

II. TWO NEW SPECIES OF HETERODERMIA

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ABSTRACT Two new species of the genus *Heterodermia* from China are described: *Heterodermia orientalis* J. B. Chen et D. P. Wang and *Heterodermia sinocomosa* J. B. Chen. *H. orientalis* differs from other members of this genus in containing a UV+ substance and a glaucous pigment (K-). *H. sinocomosa* is distinguished from *H. comosa* by the presence of K+ purple pigment, having pruina at apices of lobes, and lacking soredia.

KEYWORDS new species, *Heterodermia orientalis*, *Heterodermia sinocomosa*, China

Introduction

In his supplementary notes on the genus *Anaptychia* (s. lat.), Kurokawa(1973) recorded 88 species in the world, of which 79 species belong to the genus *Heterodermia*. Since that time over 10 new species and new combinations have been reported, including *H. crocea* R. C. Harris, *H. desertorum* Kalb, *H. flavosquamosa* Aptroot & Sipman, *H. follmannii* Sipman, *H. lepidota* Swinsc. & Krog, *H. namaquana* Brusse, *H. papuana* Aptroot & Sipman, *H. peruviana* Kashiw. et Kurok., *H.*

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pinnata Sipman, *H. spathulifera* Moberg & Purvis, *H. sitchensis* Goward & Noble, *H. albicans* (Pers.) Swinsc. & Krog, and *H. rubricosa* (Stirt.) Poelt. On the other hand *A. albopruinosa* (=*H. albopruinosa*) was reduced as a synonym of *H. diademata* and *H. tremulans* as a synonym of *H. speciosa* (Swinscow & Krog, 1976). About 90 species were known in this genus before the present study. The author is now describing two new species. Chemical constituents of specimens studied were determined by TLC method (Culberson, 1972).

New species

Heterodermia orientalis J. B. Chen et D. P. Wang, sp. nov. Fig.1

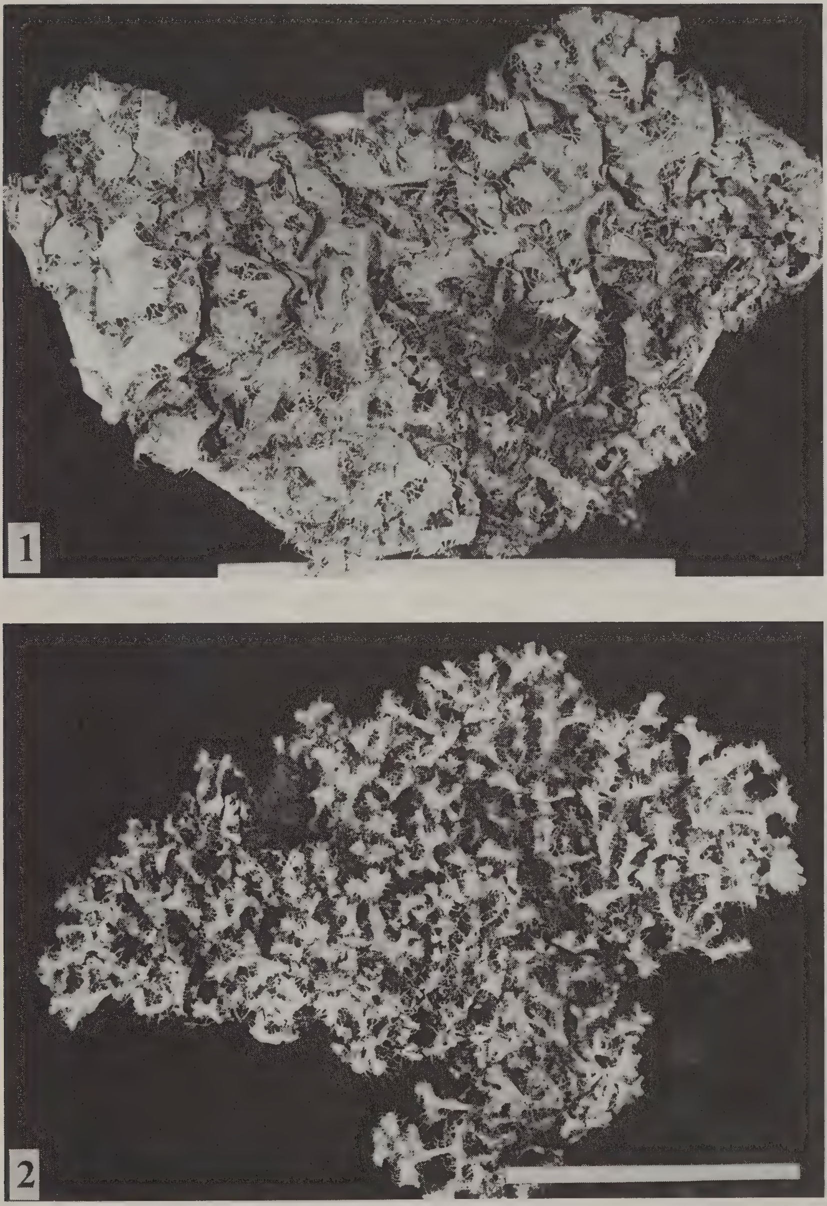
Species nova substantiam UV+ et pigmentum glauceum(K-) continenta a congeneribus diversa.

Type: CHINA. Yunnan, Tengchong county, about 50Km from the county city, alt. 2000m, on tree, June 15, 1981, X. Y. Wang *et al.* 2797 (holotype in HMAS-L).

Thallus foliose, forming rosettes 3-4cm across; lobes subimbricate, subascending, 1-2mm wide, slightly convex, with round apices, up to 3.5 mm wide; the upper surface greyish white, without soredia, isidia, pruina , and laminal cilia; marginal cilia concolorous with thallus, 1-2mm long, simple and branched; the lower surface decorticate, with red hyphae and glaucous hyphae overlaying medulla, K-. Apothecia not seen.

TLC: atranorin, zeorin, norstictic acid, UV+ substance, and a glaucous pigment.

This new species apparently belongs to members of the podocarpa group in *Heterodermia*, but it differs from other members known of this genus in containing a UV+ substance and a glaucous pigment (K-). In *Heterodermia,* UV+ substances were only known in the past in *H. papuana* described by Aptroot & Sipman. This species belongs to the leucomela group and contains several unknown UV+ substances (Aptroot & Sipman, 1991). The UV+ substance in *H. orientalis* is white



Figs. 1-2. Two new species of *Heterodermia*. -1. *Heterodermia orientalis* (holotype). -2. *Heterodermia sinocomosa* (holotype). Scales=2cm.

with slightly blue tones under UV light, its spot lies in the bottom of Rf class 6 in solvent system C (Rf value: 0.57). Lobes of this species lack lower cortex. The color of under side is unique. Both of red and glaucous hyphae overlay the medulla (K-). The red color may be not natural, although the red hyphae overlay larger area of the under side of lobes. After acetone was added in a small test tube in which there were fragments of lobes the color of acetone in the tube slowly become glaucous. A clear glaucous spot occurred in TLC plate after evaporation of solvent and its Rf value is 0.61. None of other pigment spots occurred on TLC plate.

Heterodermia sinocomosa J. B. Chen, sp. nov. Fig.2

Species nova cum thallo ut in *Hetrodermia comosa* sed ab hac specie pigmentum ochraceum K+ purpuratum continenta et cum pruinis et sine sorediis differt.

Type: CHINA. Yunnan, Lijiang, Mt. Yulongshan, alt. 2800m, on frutex, Dec. 6, 1960, J. D. Zhao and Y. B. Chen 3856 (holotype in HMAS-L).

Thallus foliose, forming rosettes ca. 5cm across; lobes subimbricate, ascending, 0.7-1.5mm wide, slightly convex, dilated toward apices, up to 2.5mm wide; the upper surface greyish white, with pruina near apices, with numerous laminal and marginal cilia, cilia 0.7-2mm long, white or pellucid at base, becoming dark brown or black toward apices and frequently branched; the lower surface decorticate, canaliculate, arachnoid, white and with ochraceous pigment, K+ purple. Apothecia not seen.

TLC: atranorin, zeorin and 1-2 other triterpenes, and pigment (K+purple).

This new species is closely related to *H. comosa* and *H. peruviana* because they have similar thallus and lobes with cilia on the upper surface. However, it can be distinguished from the latter two species by the following characters: (1) the presence of K+ purple pigment, whereas the pigment is K- in the latter two species (Swinscow *et al.*, 1976; Kashiwadani *et al.* 1990), (2) having pruina at apices of upper surface of lobes, which are absent in *H. comosa* and *H. peruviana,* (3) shorter cilia (0.7-2mm long) and becoming dark brown or black toward apices and frequently branched, whereas those in the latter two species are longer (2-4mm long), white and simple or rarely sparsely branched. In addition, the new species lacks soredia which are present in *H. comosa.*

The type specimen was reported under name *Anaptychia hypochraea* by Zhao *et al.* (1982, p.143). However, *A. hypochraea* (=*H. hypochraea*) lacks laminal cilia on the lobes and is distributed in eastern Asia, south American (Kurokawa, 1973), and east Africa (Swinscow & Krog, 1976), while *H. sinocomosa* has laminal cilia and is known only from the type locality at present.

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THE LICHEN FAMILY PHYSCIACEAE (ASCOMYCOTA) IN CHINA Ⅲ. TEN SPECIES OF HETERODERMIA CONTAINING DEPSIDONES

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Abstract: Ten species containing depsidones of the genus *Heterodermia* from China are reported in the present paper. Among them *Heterodermia pacifica* is recorded in mainland China for the first time and *H. rubescens* is new to China. Apart from *H. podocarpa* each species exhibits at least two chemotypes, indicative of the chemical diversity of these species.

Keywords: *Heterodermia*, chemical diversity, new record, *H. rubescens, H. Pacifica*

Introduction

Norstictic and salazinic acids are the most common depsidones present in the genus *Heterodermia*. In his monograph and supplementary notes on the genus *Anaptychia*(s. lat.), Kurokawa(1962, 1973) reported that norstictic acid is always produced in association with salazinic acid in this genus. The present study shows that six species from China, *Heterodermia dendritica, H. japonica, H. pacifica, H. propagulifera, H. pseudospeciosa*, and *H. rubescens* produce norstictic acid as the sole depsidone or in combination with salazinic acid. Further, three species, *Heterodermia angustiloba, H. dissecta,* and *H. microphylla*, ocassionaly produce norstictic acid as an

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accessory compound but lack salazinic acid. Each of the above 9 species exhibits at least two chemotypes, indicative of their chemical diversity. However, among the Chinese collections only one chemotype was observed for *Heteodermia podocarpa*.. All specimens examined in the present study were tested by TLC methods (Culberson, 1970, 1972) and deposited in HMSA-L and FPI.

Key to species containing depsidones in China

1. Lower surface corticate
2. Dissectic acid present, ±norstictic acid present
3. Lobules absent .... **1. H. angustiloba**
3. Numerous lobules present .... **2. H. dissecta**
2. Dissectic acid absent, norstictic acid always present
4. Soralia present .... **9. H. pseudospeciosa**
4. Soralia absent .... **10. H. rubescens**
1. Lower surface ecorticate
5. Lobes ascending or suberect
6. Lower surface with yellow pigments, K+ purple .... **6. pacifica**
6. Lower surface white, lacking pigments .... **7. H. podocarpa**
5. Lobes not ascending
7. Lower surface with yellow pigments, K+ purple
8. Soralia present .... **8. H. propagulifera**
8. Soralia absent .... **3. H. dendritica**
7. Lower surface white, lacking pigments
9. Apical soralia present, spores with sporoblastidia .... **4. H. japonica**
9. Numerous lobules present, spores without sporoblastidia ..... **5. H. microphylla**

The Species

1. Heterodermia angustiloba (Mull. Arg.) Awas.

Geophytology **3**: 113 (1973).

Chemistry: Chemotype I containing atranorin, zeorin and dissectic acid; Chemotype II containing atranorin, zeorin, dissectic and norstictic acids.

This species is characterized by corticate lower surface, narrow lobes (0.7-1.2 mm wide), and the presence of dissectic acid. It is distinguished from *H. diademata* by producing dissectic and ±norstictic acids, and from *H. dissecta* by lacking lobules.

Kurokawa (1973) reported that norstictic acid and salazinic acid occur in some specimens of this species. However, none of Chinese specimens produce salazinic acid but a few do contain norstictic acid. On a world basis this species exhibits 3 chemotypes: lacking depsidones, with norstictic acid but lacking salazinic acid, and with both norstictic acid and salazinic acid. Dissectic acid is common to all three chemical races.

In China, *H. angustiloba* occurs in both in tropical and subtropical regions.

Representative specimens examined: **Hunan**, Sangzhi, Mt. Tianpingshan, alt. 1400m, J. B. Chen et al. 9981, 9990-2. **Guizhou**, Mt. Fanjingshan, alt. 2400 m, J. B. Chen 6449-2, 6456-1. **Yunnan**, Lushui, alt. 3000 m, X. Y. Wang *et al.* 1896, 1905.

2. Heterodermia dissecta (Kurok.) Awas.

Geophytology **3**: 113 (1973).

Chemistry: Chemotype I containing atranorin, zeorin, dissectic acid; Chemotype II containing atranorin, zeorin, dissectic and norstictic acids.

This species is characterized by the presence of numerous narrow and marginal lobules and in producing dissectic acid. It is distinguished from *H. angustiloba* by the presence of these lobules. As is the case with *Heterodermia microphylla,* the lobules in *H. dissecta* are narrow, often ascending, and sometimes becoming sorediate. However, *H. microphylla* lacks both a lower cortex and dissectic acid.

Nearly 50% of the Chinese collections of this species produce norstictic acid but lack salazinic acid, although salazinic acid was reported previously for some specimens of this species (Kurokawa, 1973).

In China, *Heterodermia dissecta* occurs in several subtropical localities. All specimens reported as *Anaptychia dissecta* by Zhao et al. (1982) have now been reidentified as *Heterodermia diademata* but the presence of authentic *H. dissecta* in mainland China is reported in the present paper.

Representative specimens examined: **Hunan**, Sangzhi, Mt. Tianpingshan, alt. 1400 m, J. B. Chen et al. 9365, 9488. **Guangxi**, Huaping, Zhao & Xu 10354. **Sichuan**, Mt. Emai, alt. 1000 m, Zhao & Xu 6755. **Yunnan**, Xichou, alt. 1400-1650 m, J. B. Chen 5210, 5263, 5306.

3. Heterodermia dendritica (Pers.) Poelt

Nova Hedwigia **9**: 31 (1965).

Chemistry: Chemotype I containing atranorin, zeorin, and norstictic acid; Chemotype II containing atranorin, zeorin, norstictic and salazinc acids. Pigments are common.

Morphologically this species is very similar to *H. flabellata* but is distinguished by the presence of norstictic acid and (±)salazinic acid. *Heterodermia dendritica* also resembles *H. propagulifera* but lacks soredia.

Kurokawa (1962, 1973) reported that both norstictic and salazinic acids occur in this species. However, 17 of 19 Chinese specimens examined lacked salazinic acid.

Representative specimens examined: **Fujian**, Mt. Wuyishan, alt. 1400-1970 m, J. B. Chen and S. L. Wang 14251, 14649, 14565. **Hunan**, Sangzhi, Mt. Tianpingshan, J. B. Chen et al. 9893, 9989. **Anhui**, Mt. Huangshan, alt. 1500 m, J. B. Chen 14715, 14727-1. **Yunnan**, Xichou, J. B. Chen 5109; Gongshan, J. J. Su 2754.

4. Heterodermia japonica (Sato) Swinsc. & Krog

Lichenologist **8**: 122 (1976).

= *Anaptychia japonica* (Sato) Kurok. var. *reagens* Kurok. J. Jap. Bot. **35**: 354 (1960).

= *Anaptychia chilensis* Kurok. var. *austroafricana* Kurok. J. Hattori Bot. Lab. **37**: 600 (1973).

Chemistry: Chemotype I containing atranorin, zeorin; Chemotype II containing atranorin, zeorin, and norstictic acid; Chemotype III containing atranorin, zeorin, norstictic and salazinic acids.

This species is characterized by apical labriform soralia, a decorticate lower surface which lacks pigments, and spores with sporoblastidia.

Swinscow & Krog (1976) reported that chemotypes I and IIare common in East Africa. In China this species includes 3 chemotypes as recorded above.

Representative specimens examined: **Heilongjiang**, Xiaoxing'anling, X. L. Chen 5201, 5190. **Jilin**, Wangqing, X. D. Lu 848069-2. **Fujian**, Mt. Wuyishan, alt. 1000-1950 m, J. B. Chen & S. L. Wang 14257, 14319, 14657. **Anhui**, Mt. Huangshan, J. B. Chen 14716-7, 14718. **Hunan**, Zhangjiajie, J. B. Chen et al. 9071. **Guizhou**, Mt. Fanjingshan. alt. 1500 m. J. B. Chen 6373. **Yunnan**, Xichou, J. B. Chen 5012, 5051; Weixi, alt. 2500 m, X. Y. Wang et al. 4207. **Sichuan**, Wolong, alt. 2200-2600 m, J. B. Chen 6270; X. Y. Wang et al. 9656, 9719.

5. Heterodermia microphylla (Kurok.) Skorepa

Bryologist **75**: 490 (1972).

Chemistry: Chemotype I containing atranorin and zeorin; chemotype II containing atranorin, zeorin, and norstictic acid.

Whereas East African collections of *Heterodermia microphylla* lack depsidones (Swinscow & Krog, 1976)., specimens from Japan and Korea are reported to contain both salazinic and norstictic acids (Kurokawa, 1973).

The lobules of *Heterodermia microphylla* are often very narrow, ascending, and sometimes forming soredia, similar to those present in *H. dissecta*. However, *H. dissecta* differs in containing dissectic acid and in having a corticate lower surface. This species is distinguished from *Heterodermia hypoleuca* by the presence of numerous lobules.

In China, *Heterodermia microphylla* is known from several localities in the northeast.

Representative specimens examined: **Heilongjiang,** Dailing, X. L. Chen 3696, 3786; Daxing'anling, alt. 1000 m, C.F. Zhao 1113. **Jilin**, Dunhua, C. F. Zhao 4006, 4119.

6. Heterodermia pacifica (Kurok.) Kurok.

Folia Cryptogamica Estonica **32**: 23 (1998).

Chemistry: Chemotype I containing atranorin, zeorin, norstictic acid; Chemotype II containing atranorin, zeorin, norstictic and salazinic acids. Pigments (K+ purple) are common.

This species is characterized by spathulate lobes, a decorticate lower surface with yellow pigments (K+ purple), spore with sporoblastidia, and the production of depsidones. This species is separated from *H. hypochraea* by the presence of depsidones and from *H. podocarpa* by the presence of yellow (K+ purple) pigments on the lower surface.

In his original description of this species, Kurokawa (1973) reported the presence of norstictic and salazinic acids. However, in China this species includes both chemotype I with norstictic acid but lacking salazinic acid as well as chemotype II.

In China, previously *Heterodermia pacifica* was recorded in Taiwan (Kurokawa, 1973) but is now reported from mainland China.

Representative specimens examined: **Heilongjiang**, Dailing, alt. 350 m, X. L. Chen 3874, 3966, 4027-1. **Jilin**, Helong, alt. 950 m, C.F. Zhao 3755. **Zhejiang**, Mt. Tianmushan, X. L. Chen 1011. **Hunan**, Zhangjiajie, alt. 1000 m, J. B. Chen et al. 9042. **Fujian**, Mt. Wuyishan, J. B. Chen and S. L. Wang 14117. **Yunnan**, Gongshan, alt. 1500-2000 m, J. J. Su 3281, 3916.

7. Heterodermia podocarpa (Bel.) Awas.

Geophytology **3**: 114 (1973).

Chemistry: atranorin, zeorin, and norstictic acid.

Heterodermia podocarpa resembles both *H. pellucida* and *H. pacifica*, but it is distinguished from the former by producing depsidones and from the latter in lacking yellow pigments (K+ purple) on lower surface.

Both Asian(Kurokawa 1962, 1973; Awasthi 1988) and East African collections of this species (Swinscow & Krog, 1976) are reported to contain both norstictic and salazinic acids. However, like the Peruvian collections of *Heterodermia podocarpa* (Kashiwadani & Kurokawa, 1990), specimens from China contain norstictic acid but lack salazinic acid. Thus this species includes two chemotypes, with or without salazinic acid.

In China *H. podocarpa* is known in several localities in southwest China.

Representative specimens examined: **Yunnan**, Xishuangbanna (belonging to tropics), J. B. Chen 6558-6, 6570; Lushui, alt. 2400-2800 m, X. Y. Wang et al. 1763, 2273, Gongshan, alt. 1600-2200 m, J. J. Su 2764, 3431. **Xizang**, Chayu (near Yunnan), alt. 2700 m, J. J. Su 4231.

8. Heterodermia propagulifera (Vain.) Dey.

In B. C. Parker & Roane (Eds.), Distributional History of the Biota of the Southern Appalachians, 4. Algae and Fungi (Charlottesville): 403, 1976 (1977).

Chemistry: Chemotype I containing atranorin, zeorin, and norstictic acid; Chemotype II containing atranorin, zeorin, norstictic and salazinic acids. Pigments (K+ purple) are common.

This species resembles both *Heterodermia obscurata* and *H. dendritica*, but *H. obscurata* lacks depsidones and *H. dendritica* lacks soredia.

Originally norstictic and salazinic acids were considered to be constant components of *H. propagulifera* (Kurokawa 1962, 1973) but Kashiwadani & Kurokawa (1990) reported that collections of this species from Peru lack salazinic acid. Most of the Chinese specimens examined produced both norstictic and salazinic acids, but a few lacked salazinic acid.

In China, this species is distributed in both tropical and temperate regions.

Representative specimens examined: **Heilongjiang**, Dailing, X. L. Chen 5459. **Jilin**, Chanbai, alt. 1836 m, X. L. Chen 2201. **Hubei**, Shennongjia, alt. 3000 m, J. B. Chen 10923, 11424. **Hunan**, Sangzhi, Mt. Tianpingshan, alt. 1380 m, J. B. Chen et al. 9484, 9505. **Yunnan**, Kunming, Mt. Xishan, J. B. Chen 6476-1; Xishuangbanna, alt.. 1400 m, Y. M. Jiang 1096; Deqin, alt. 3500 m, J. J. Su 5699. **Sichuan**, Mt. Emei, alt. 3100 m, J. B. Chen 6277, 6279-1; Jiuzhaigou, J. B. Chen 6066.

9. Heterodermia pseudospeciosa (Kurok.) W. Culb.

Bryologist **69**: 484 (1966).

Chemistry: Chemotype I containing atranorin, zeorin, and norstictic acid; Chemotype II containing atranorin, zeorin, norstictic and salazinic acids.

This species is characterized by having lower cortex, labriform soralia and the production of depsidones. The latter feature distinguishes it from *H. speciosa*. In addition, the soralia in *H. pseudospeciosa* are usually composed of granular soredia, while the soralia in *H. speciosa* are usually composed of farinose soredia. The related species, *H. rubescens,* lacks soredia although it is chemically similar to *H. pseudospeciosa.*

Norstictic and salazinic acids were considered to be constant chemical components of this species (Kurokawa, 1962, 1973). These two dipsidones also occur in collections of this species from India and Nepal (Awasthi, 1986) and Peru (Kashiwadani & Kurokawa, 1990). However, the holotype of this species and specimens from East Africa lack salazinic acid (Swinscow & Krog, 1976). In the present studies we found that 47 of 54 Chinese specimens produced both norstictic and salazinic acids, but 7 specimens lacked salazinic acid.

This species is widely distributed in China but does not occur in the northwest regions.

Representative specimens examined: **Liaoning**, Zhuanghe, X. L. Chen 5877, 5916. **Anhui**, Mt. Huangshan, alt. 1200-1600 m, Zhao & Xu 5342, 5431, 5638; J. B. Chen 14714. **Hubei**, Shennongjia, alt. 2270 m, J. B. Chen 11613. **Hunan**, Zhangjiajie, alt. 500-800 m, J. B. Chen et al. 8984, 9015; Sangzhi, Mt. Tianpingshan, alt. 1400 m, J. B. Chen et al. 9393, 9430. **Fujian**, Mt. Wuyishan, J. B. Chen & S. L. Wang 14248, 14618. **Guangxi**, Huaping, Zhao & Xu 9716. **Yunnan**, Xichou, J. B. Chen 5181, 5307; Lushui, alt. 2000-2400 m, X. Y. Wang et al. 2105, 2142. **Sichuan**, Mt. Gonggashang, X. Y. Wang et al. 8892. **Xizang**, Zuogong, alt. 2800, J. J. Su 5311.

10. Heterodermia rubescens (Kurok.) Awas.

Geophytology **3**: 114 (1973)

Chemistry: Chemotype I containing atranorin, zeorin and norstictic acid;

chemotype II containing atranorin, zeorin, norstictic and salazinic acids.

This species is similar to *H. angustiloba* and *H. diademata* in external appearance, but *H. angustiloba* contains dissectic acid whereas *H. diademata* lacks depsidones. This species is distinguished from *H. pseudospeciosa* in lacking soredia.

Kurokawa (1973) and Awasthi (1988) reported that norstictic acid is always produced in association with salazinic acid in this species. However, 2 of 5 known specimens from China produced norstictic acid alone, while 3 specimens produced both norstictic and salazinic acids.

Although *H. rubescens* is known previously from the Himalayan region, here we record it from China for this first time. In China this species has been collected from rock and bark in Yunnan Province.

Representative specimens examined: **Yunnan**, Xichou, alt. 1400 m, J. B. Chen 5328; Malipo, Mt. Laojunshan, alt. 1400 m, J. B. Chen 5437; Lushui, alt. 2400, X. Y. Wang et al. 1794; Yingjiang, X. Y. Wang et al. 2901, 3145.

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TWO NEW SPECIES OF HOHENBUEHELIA FROM ARGENTINA

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Abstract: During a revision of the genus *Hohenbuehelia* in Argentina, two new species were found: *H. austrocedri* from the province of Chubut, and *H. minutissima* from the province of Buenos Aires. Both belong to subgenus *Hohenbuehelia* section *Nigricans*.

In the present paper we describe and illustrate the two new species and compare them with *H. singeri*, *H. nigra*, *H. bullulifera* and *H. unguicularis*. In addition, we studied the holotype of *H. pilitomaculoides*, which we reduce to a synonym of *H. nigra*.

Key Words: Agaricales, *Hohenbuehelia austrocedri*, *H. minutissima,* H. sect. Nigricans, systematics.

INTRODUCTION

Knowledge of the genus *Hohenbuehelia* in Argentina is scant. Spegazzini described several new taxa as *Agaricus portegnus* Speg., *Pleurotus paraguayensis* Speg., *P. portegnus*. var *microspora* Speg. And *P. petaloides* var *victoriensis* Speg. (Spegazzini 1881, 1902, 1921, 1922). Singer & Digilio (1951) published *Hohenbuehelia bullulifera* Singer; while later Raithelhuber (1984, 1990) described *H. pinicola* Raithelhuber and *H. canubronea* Raithelhuber. Recently Albertó *et al.*, (1998) studied the *H. nigra* complex and described *H. singeri* (Singer) Albertó & Fazio and *H. nigra* var *pileocystidiata* Fazio & Albertó.

In the present paper we illustrate and describe two new species, one from the Province of Chubut and the other from Province of Buenos Aires, Argentina. We compare them with *H. singeri*, *H. nigra* (Schwein.) Singer, *H. bullulifera* and *H. pilitomaculoides* Libonati-Barnes. After studing the type material of *H. pilitomaculoides*, which also belongs to section Nigricans, we consider this species to be a late synonym of *H. nigra*.

MATERIALS AND METHODS

Dried specimens were studied macro- and microscopically. Color terms and annotations follow Munsell (1954). Abbreviations of author's names are according to Kirk and Ansell (1992). Freehand sections of specimens were mounted in 10 % KOH plus 1 % aqueous solution of phloxine and in Melzer's reagent. All collections are deposited in the mycological Herbarium, Dept. de Ciencias Biológicas, Facultad de Ciencias Exactas y Naturales, University of Buenos Aires (BAFC). Herbaria abbreviations follow Holmgren *et al.* (1990).

RESULTS

KEY TO SPECIES OF SECTION NIGRICANS STUDIED

1. Pileocystidia absent 2
1 Pileocystidia present 4
  2 Leptocystidial pleurocystidia absent or inconspicuous; spores > 6 µm long. .... *H. unguicularis*
  2 Leptocystidial pleurocystidia present; spores ≤ 6 µm long 3
3 Pileus small, up to 2.5 mm diam., pseudostipe present; spores 5.2-6.0 X 3.1-3-6 µm .... *H. minutissima*
3 Pileus larger, up to 5 mm diam., pseudostipe absent; spores 4-5(-5.5) X 3-5 µm .... *H. singeri*
  4 Pileocystidia thin-walled 5
  4 Pileocystidia metuloid 6
5 Cheilocystidia leptocystidia, vesiculose-pedicellate .... *H. bullulifera*
5 Cheilocystidia metuloid, ventricose to fusiform .... *H. subbarbata*
  6 Spores 9-10.5 µm long; pleurocystidia hyaline .... *H. austrocedri*
  6 Spores 6.5-8 µm long; pleurocystidia brown 7
7 Two types of pileocystidia present; cutis formed by only one type of hyphae .... *H. nigra* var. *pileocystidiata*
7 One type of pileocystidia present; cutis formed by three types of hyphae .... *H.nigra* var. *nigra*

Hohenbuehelia austrocedri Fazio & Albertó sp. nov.

Basidiocarpus pileatus, conchatus, nigrus, unguicularis, ad duorum textus, inferus tomentosus brunneo-castaneus, ad margo canescenti. Stipes absens, pileus ad substratum adhaerentibus in locus unicus. Lamellae obscure griseae, subconfertis vel subdistantibus, margo liso, cum lamellulae intercalares. Pulvis sporarum niveis.

Sporis 9-10,5 x 4-4,5 µm, cylindricis vel ellipsoideis, hyalinis, laevis, inamyloideis. Basidiis 38-55 x 6-8 µm, longe sterigmaticis. Cheilocystidiis 32-41,5 x 6-12,5 µm, gracilis, extremis globosis, incrustatis, crystallis brunneis amorphibus, in alkali dissolventis. Pleurocystidiis formae magnitudinisque. Pileipellis hyphis curtis, brunneis, crassitunicatis, exornatis. Mycosclereidiis irregularibus, crassitunicatis. Pileocystidiis metuloideis, hyalinis, *crassitunicatis, incrustatis; crystallis amorphis in alkali dissolventes. Pilus duorum hyphis formatus: a) brunneis, crassitunicatis, efibulatis; b) hyalinis, crassitunicatis, parce fibulatis chlamydosporis interdum preasentibus. Subpileus strato gelificatus 150-300 µm et hyphis hyalinis, tenuicatis, fibulatis exornatis.*

Hab. ad corticeum muscosis Austrocedri chilensis

HOLOTYPUS: ARGENTINA, Chubut, PN. Lago Puelo, Lago Puelo, in Austrocedreto, pr. flumine Los Tineos, intefolia dejecta Austrocedri chilensis, leg. M. Rajchenberg (11.180), 10-V-96 in herbarium BAFC sub n° 34.999 conservatus est.

Basidiocarp 5-15 X 5-20 mm, pileate, conchate, dark brown to black (5YR 2/2 - 10YR 3/3), with a brown (10YR 4/3) tomentum at the base which covers 2/3 of the pileus surface, then becomes a whitish pruina towards the margin. Stipe absent, the pileus is laterally attached to substratum by part of the underside (Fig. 1A and B). Lamellae very dark gray (75YR 3/1), close to subdistant; lamellar margin entire, with small intercalary lamellulae, interlamellar space yellowish brown (10YR). Spore print white.

Spores 9-10.5 X 4-4.5 µm, cylindric to ellipsoid, thin-walled, hyaline, smooth, non amyloid (Fig. 1D and 2I)). Basidia 38-55 X 6-8 µm, with sterigmata 7 µm long, clavate, 4-spored, densely guttulated (Fig. 2D). Cheilocystidia 32-41.5 X 6-12.5 µm, thin, apex subglobose, encrusted with small, amorphous brown crystals which are soluble in KOH. Pleurocystidia of identical shape and size (Fig. 2A, C). Pileipellis formed by short, brown, very thick-walled hyphae (Fig. 2G), 5.5-7.5 µm diam. and modified, thick-walled, brown structures similar to mycosclereids (Wright, 1955), 12-22 X 3.5-6 µm very irregular in shape. Pileocystidia 17-26 X 6-12 µm, metuloid, hyaline, very thick-walled, covered with encrusted amorphous crystals which are soluble in 10 % KOH (Fig. 2B). The hairs of the tomentum are formed by two types of erect hyphae: a) brown to ochraceous-brown, thick-walled, tortuous, clampless hyphae, 1.5-3 µm diam., and b) less abundant, hyaline, thick-walled hyphae, with few clamps (Fig. 2F and H). Terminal and intercalar chlamydospores, 7-20 µm diam. can be observed in some specimens (Fig. 2E). Context formed by a loose trama of hyaline, thin, clamped hyphae with gelatinized walls, 3-8 µm diam., that define a layer 150-300 µm thick.

Habitat: growing among musci on wet bark of *Austrocedrus chilensis*.

Material studied: The holotype: ARGENTINA, Chubut, Pque. Nac. Lago Puelo, Lago Puelo, forest of *Austrocedrus chilensis* next to the stream Los tineos, leg. M. Rajchenberg (11.180) growing on bark, 10-V-96, BAFC 34.999; Chubut, Pque. Nac. Lago Puelo, Lago Puelo, forest of *Austrocedrus chilensis* next to the stream Los tineos, leg. M. Rajchenberg (11.145) growing on bark, 10-V-96 (CIEFAP); Chubut, Pque. Nac. Lago Puelo, lago Puelo, West branch, International Boundary, in mixed forest of *Austrocedrus chilensis*, *Nothofagus dombeyi* and *Guevinia avellano*, leg. M. Rajchenberg (11.175), 10-V-96 (CIEFAP).

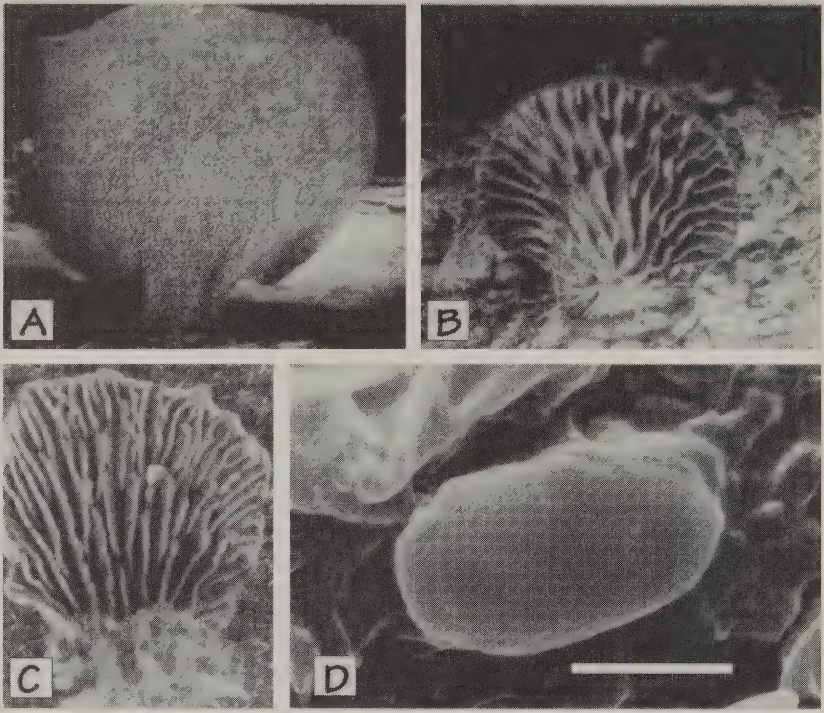

Fig. 1: *Hohenbuehelia austrocedri* and *H. minutissima*. A and B, Basidiocarp of *H. austrocedri*; D, Spore of *H. austrocedri* under SM; C, Basidiocarp of *H. minutissima*. Scale bar Fig. A and B= 10 mm, C = 1 mm, D= 5 μm.

Hohenbuehelia minutissima Fazio & Albertó sp. nov.

Basidiocarpus minutus, petaloideus, spathulatus, substipitatus, flabellatus, pruinosus, obscure cinereus, pruina nivescentibus, pili pseudostipitem abundantibus, concoloribus, hirsutibus, zona ad pilea glabra, cremea vel alba; margo sinuatus.

Sporis 5-6 x 3-3,6 μm, ellipsoideis, hyalinis, laevis, inamyloideis. Basidiis tetrasporis. Pleurocystidiis claviformibus, 21-27 x 11-16 μm, tenuitunicatis, incrustatis, cum yodo metuloideis simulantibus in alkali dissolventis. Pileipellis hyphis hyalinis, tenuitunicatis,

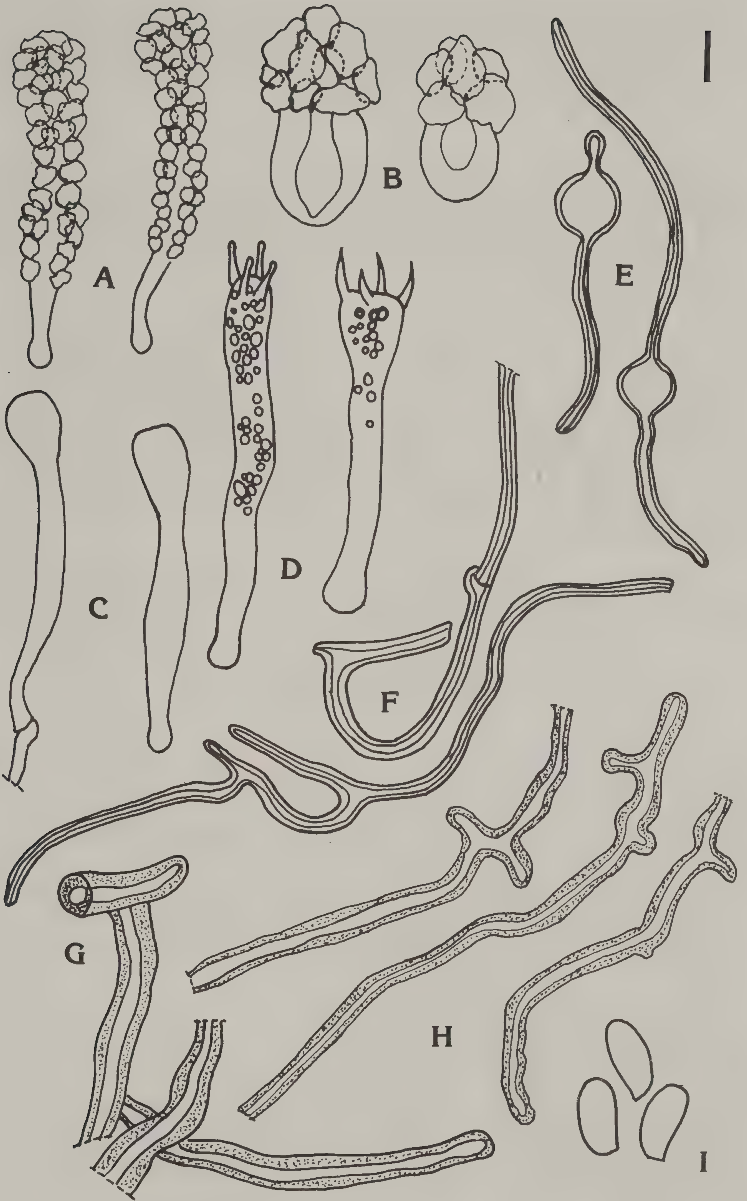

Fig. 2: Microscopic features of *Hohenbuehelia austrocedri*. A, Pleurocystidia; B, Pileocystidia covered with amorphous crystals; C, Pleurocystidia without crystals; D, Basidia; E, Chlamydospores; F and H, Hyphae of the hairs of the tomentum; G, Hyphae of the pileipellis; I, Spores. Scale bar 6 µm.

fibulatis, ramificatis exornatis. Hyphis contextibus idem in matricibus plus minusve gelificatis immersis. trama lamellibus hyphis conductivis pallide brunneis, tenuitunicatis efformantibus.

Holotypus: ARGENTINA, Bonariae, Llavallol, Sta. Catalina, leg. Enrique Fernández, 14.III.94, in herbarium sub. nº BAFC: 34.374 conservatus est.

Basidiocarp 1-3 X 1-2.5 mm, petaloid, spathulate, substipitate, flabelliform, pruinose, very dark gray (10YR 3/1), with whitish pruina; pseudostipe with abundant erect concolorous hairs, then becoming smooth, white to cream colored; margin of pileus slightly festooned (Fig. 1C and 3F). Lamellae gray (10YR 5/1), eccentric, margin entire.

Spores 5.2-6.0 X 3.1-3.6 µm, ellipsoid, hyaline, smooth, non amyloid (Fig. 3E). Basidia 25-27 X 6-7 µm, clavate, 4- spored. Cheilocystidia not observed. Pleurocystidia 22-27 X 11.5-15.5 µm, clavate, thin-walled, encrusted with amorphous crystals, appearing metuloid in Melzer's reagent, crystals soluble in KOH (Fig. 3C and D). Pileipellis formed by hyaline, straight, thin-walled, clumped, branched, interwoven hyphae, 2-3 µm diam., immersed in a more or less gelatinized matrix (Fig. 3A). Trama of the lamellae with pale brown, thin-walled, clumped, conducting hyphae, 2.6-3.1 µm (Fig. 3B).

Material studied: Holotypus: ARGENTINA, Buenos Aires, Llavallol, Sta. Catalina, leg. E. Fernández, 14.III.94, BAFC: 34.374

DISCUSSION

Subgenus *Hohenbuehelia* Section *Nigricans*, includes species with black lamellae and smooth spores. After studying many species of this section it was possible to differentiate clearly two groups: 1) species with metuloid pleurocystidia, thick-walled, with the apex covered with regular polyhedric crystals, which we name "pleurocystidia nigra type" (see Albertó *et. al.* 1998); 2) species with lamprocystidiate pleurocystidia, covered all along the surface by anamorphous crystals, which easily dissolve in KOH, appearing metuloid when observed with the crystals but actually thin-walled, which we name "pleurocystidia singeri type" (Fig. 3C and D). *Hohenbuehelia austrocedrii* and *H. minutissima* belong to the latter group.

Hohenbuehelia austrocedrii is characterized by a dark pileus covered by a brown tomentum, subdistant lamellae, yellowish brown interlamellar space, thin-walled cystidia, covered by amorphous, opaque crystals that dissolve in KOH, and by long cylindrical spores. We observed that, in some young specimens, lamellae are yellowish-brown, the same color as the interlamellae space. The lamellae become darker during basidiocarp development and, finally, become very dark gray in mature specimens.

H. minutissima is characterized by a minute basidiocarp, a pseudostipe with abundant erect hairs, thin-walled cystidia covered by amorphous crystals which are easily soluble in KOH, and by the presence of pale brown conducting hyphae in the trama of the lamellae.

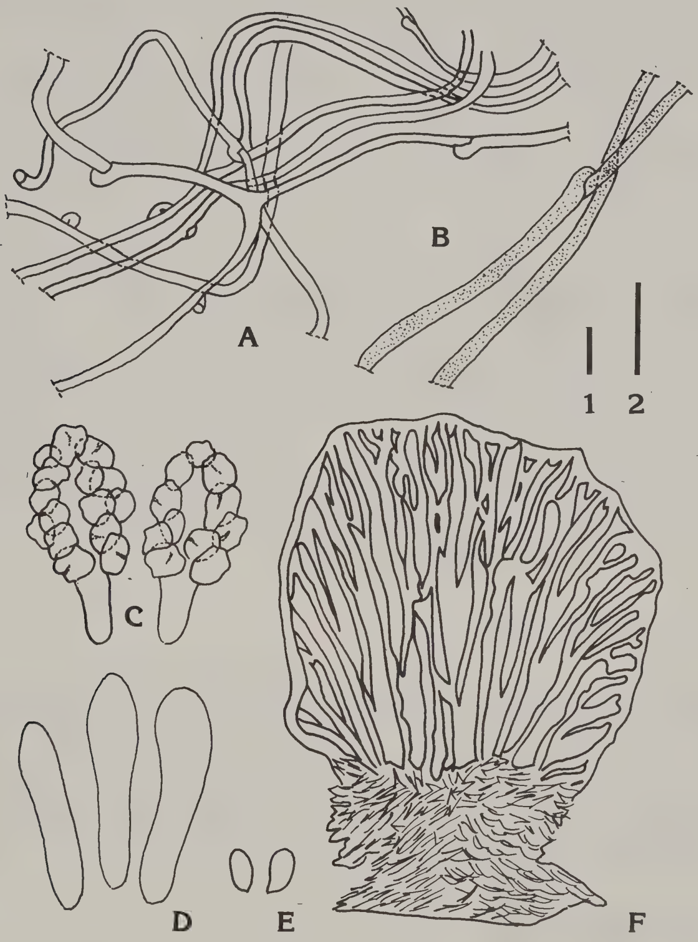

Fig. 3: *Hohenbuehelia minutissima*. A, Hyphae of the pilleipellis; B, Conducting hyphae of the trama of the lamellae; C, Pleurocystidia covered with amorphous crystals; D, Pleurocystidia without crystals; E, spores; F, Basidiocarp. Scale bar 1: Figs. A, B, C, D and E= 6.5 µm; Scale bar 2: Fig. F= 5 mm.

Both two new species are related with *H. singeri* because of the thin-walled pleurocystidia type, but *H. austrocedri* differs in the distinctly longer spores and the presence of mycosclereids similar to those found in *H. nigra* by Albertó *et. al.* (1998).

Hohenbuehelia minutissima differs from *H. singeri* because the latter has larger pileus, up to 5 mm diam. with a white pruina abundant in young specimens, spseudostipe absent and spores shorter, 4-5(5.5) µm long.

Comparing *H. minutissima* with *H. bullulífera* we observed that although both species have a small, dark basidiocarp and spores of similar shape and size, *H. bullulífera* lacks a stipe, has abundant fusoid, thick-walled metuloids pleurocystidia, cheylocystida that are vesiculose-pedicellate, hyaline or incrusted with brown pigment, and has subglobose well-differentiated pileocystidia similar to cheilocystidia.

H. subbarbata (Berk. & Curtis) Sing. and *H. bullulifera* are very similar species. Unfortunately we have been unable to study the original material of *H. bullulifera* in which Singer and Digilio (1951) based their description and which was originally deposited in LIL; this material is presumed lost. We based on concept of *H. bullulifera* in the data provide in the protologue.

We also studied the type material of *H. pilitomaculoides*. Libonati-Barnes (1994) reported that *H. pilitomaculoides* was very similar to *H. nigra* (Schwein.) Singer but differed because the former had lacked pileocystidia. Upon studying its holotype (WTU) we could clearly observed the presence of brown, thick-walled, crystal incrusted pileocystidia, very similar to those present in the holotype of *H. nigra* (Albertó *et al.* 1998). We thus conclude that *H. pilitomaculoides* Libonati-Barnes is a synonym of *H. nigra* (Schwein.) Singer.

ACKNOWLEDGMENTS

We are very grateful to Dr. Mario Rajchenberg (CIEFAP-ARGENTINA) who kindly sent us his collections of *Hohenbuehelia* from Patagonia, Argentina and the gift of the holotype of *H. austrocedrii* to the BAFC herbarium. We also want to thank the curator of WTU for the loan of specimens in their keeping. We are very grateful to Dr. J. E. Wright who wrote the Latin diagnosis and made invaluable suggestions to improve the paper. Dr. D. Desjardin (SFSU), provided a presubmission review for which we are most grateful. This work was funded by the CONICET; publication n° 131 of PRHIDEB.

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ÉTUDE NOMENCLATURALE DES TAXONS INFRAGENERIQUES DANS LE GENRE LACTARIUS (BASIDIOMYCOTA, RUSSULACEAE)

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Résumé

La nomenclature des taxons infragénériques des grands genres d'Agaricales est souvent négligée car embrouillée par une multitude de noms dont la validité, la légitimité et la typification sont souvent problématiques. De plus, la littérature les concernant est très dispersée et l'Index of Fungi ne les répertorie que depuis 1986 (période 1980-). Une synthèse des règles du Code et des conventions adoptées pour ce genre d'études est présentée, par le premier auteur, suivie de l'inventaire des noms publiés à ce jour dans le genre *Lactarius* Pers. et synonymes. La nouvelle combinaison *Lactarius* sect. *Deliciosi* comb. nov. [syn.: *Lactarius* sect. *Dapetes*, illégit.] est proposée.

Mots clés: nomenclature, *Lactarius* section *Dapetes*, *Lactarius* section *Deliciosi*, *Hypophyllum*.

Abstract

The nomenclature of infrageneric taxa in large genera of Agaricales is often neglected, as it is complicated by a large number of names whose validity, legitimacy and typification are often problematic. Furthermore, the literature is very dispersed and the Index of Fungi only catalogues them since 1986 (period 1980-). A synthesis of the Code's rules and the conventions adopted for such research is presented by the first author, followed by an inventory of these taxa published in the genus *Lactarius* Pers. and its synonyms. The new combination *Lactarius* sect. *Deliciosi* comb. nov. [syn.: *Lactarius* sect. *Dapetes* illegit.] is proposed.

Key words: nomenclature, infrageneric taxa, *Lactarius* section *Dapetes*, *Lactarius* section *Deliciosi*, *Hypophyllum*.

1. CONVENTIONS, ABREVIATIONS ET REGLES

DL: diagnose latine

T / HT / LT / NT : Type

Pour les noms validés avant 1958, la nature du type (“T”) est précisée. A partir de 1958, rien n’est indiqué car les noms valides possèdent nécessairement un holotype (“HT”).

l’Art. 10.1-N1 (ICBN “Tokyo”) autorise à parler d’holotype (type original), de lectotype (“LT”, issu postérieurement du matériel original) ou de néotype (“NT”, entièrement nouveau) pour des noms infragénériques, bien que ce ne soit pas d’un usage encore très courant. Cette possibilité introduisant une information qui peut être utile, nous l’adoptons. Remarquons que la désignation d’un néotype n’est possible que si la circonscription originale ne comportait aucun nom d’espèce, ou encore par conservation.

PT: Protype

Terme non classique. Définition: type original, désigné ou présumé des noms **invalides**. Le protype n’a aucune valeur nomenclaturale. Lorsqu’il n’existe pas, il n’y a pas lieu d’en désigner un.

Type automatique

S’applique aux noms infragénériques dont l’épithète finale est dérivée d’un nom d’espèce. Si le nom du taxon infragénérique original incluait explicitement ce nom d’espèce, ce dernier en est le type automatique, sauf si un autre nom d’espèce avait été désigné comme type original.

Ex.: le type automatique de *Lactarius* [rang indéfini] *Velutini* Quél. est *L. velutinus*.

Synonymes

On distingue les synonymes nomenclaturaux (ou obligatoires), qui ont le même type (signe ≡), et les synonymes taxinomiques (ou facultatifs), qui ont des types différents (signe =).

Autonymes

Les autonymes infragénériques ont le même type que le nom de **genre**. Leur épithète infragénérique répète le nom de genre (sans nom d’auteur). La règle ne s’applique pas aux subdivisions d’un sous-genre, d’une section etc. autres que celles incluant le type du nom de **genre**. Les autonymes sont prioritaires sur leurs concurrents éventuels.

Ex.: - Dans le genre *Lactarius* Pers., les s/g., sect., s/sect., série et subsérie *Lactarius* sont des autonymes. Notons qu’il n’y a pas, pour l’instant, de stirpe *Lactarius* puisque aucun nom de stirpe n’a été validé dans ce genre

- *Lactarius* sect. *Lactarius* est prioritaire sur *Lactarius* sect. *Piperati* (Fr.: Fr.) Cooke 1871, qui a le même type, *L. piperatus*.

Validité

Les épithètes de noms **invalides** sont en italiques. Ces noms n’ont aucune existence légale mais ils peuvent présenter un certain intérêt taxinomique ou historique.

Illégitimité

Elle n’est pas indiquée dans cette étude. Un nom valide mais **illégitime** ne doit pas être utilisé en pratique: seuls les noms légitimes entrent en compétition pour la priorité finale. L'illégitimité concerne tout particulièrement les homonymes et les noms superflus.

La plupart des cas d'illégitimité seront résolus en appliquant les règles suivantes:

1 - Homonymes

Lorsque plusieurs noms infragénériques valides comportent la même épithète et possèdent un type différent, ils sont considérés comme homonymes **même s'ils sont de rangs différents**. Un seul est légitime, généralement le plus ancien, sauf cas de nom superflu, sanctionné ou conservé.

Ex.: - *Lactarius* série *Plinthogali* A.H. Sm. & Hesler 1962 (dont le type est *L. lignyotus*), est un homonyme illégitime (postérieur) de:

- *Lactarius* [rang indéfini] *Plinthogali* Burl. 1908 (dont le type automatique est *L. plinthogalus*), ainsi que de ses combinaisons:
- *Lactarius* s/g. *Plinthogali* (Burl.) Hesler & A.H. Sm. 1979, et:
- *Lactarius* sect. *Plinthogali* (Burl.) Singer 1942.

2 – Noms (nomenclaturalement) superflus

Par définition, ce sont des noms qui incluent, lors de leur publication, le **type** d'un autre nom légitime de **même rang.** Le plus souvent ils incluent le nom lui-même, lequel est l'équivalent de son type. Ce cas peut se présenter sous diverses formes:

2.1. La circonscription du nouveau nom validé comprend ("inclut") un nom d'espèce qui était **déjà** le type (automatique ou désigné, d'où l'importance de connaître la date de cette désignation) d'un autre nom légitime de même rang.

2.2. Le type (original) du nouveau nom validé était **déjà** le type (automatique ou désigné) d'un autre nom légitime de même rang.

Ex.: *Lactarius* s/sect *Camphoratini* Bon 1979, T: *L. camphoratus*, est un nom illégitime, superflu pour *Lactarius* s/sect. *Olentes* (Bataille) Singer 1942 ("*Olentini*"), LT (Singer 1951): *L. camphoratus*.

2.3. Le nouveau nom validé est déclaré par son auteur **synonyme** d'un autre nom légitime de même rang (lequel aurait donc dû être employé puisque plus ancien).

Priorité

Lorsqu'un taxon occupe une place définie dans une certaine systématique, le nom correct qui doit lui être attribué est le nom légitime le plus ancien qui s'applique à ce taxon. Seuls les noms légitimes au **rang** choisi entrent en compétition pour la priorité.

Des exceptions concernent les noms sanctionnés ou conservés (mais rappelons que les noms infragénériques ne sont pas conservables).

Cet aspect n'est pas traité dans le présent travail, qui est un inventaire de noms publiés à ce jour et non le reflet d'une systématique particulière, hormis par l'indication des synonymes taxinomiques de *Lactarius* Pers.

Terminaisons

Il n'existe pas de règle permettant d'harmoniser les terminaisons des noms infragénériques selon leur rang. Des recommandations concernent seulement les nouveaux noms à publier. Les terminaisons originales doivent donc être maintenues, avec simplement un accord masculin / féminin le cas échéant.

Noms infragénériques friesiens

Pour les détails concernant les noms infragénériques publiés dans le Systema Mycologicum de Fries, nous renvoyons à Melot (1996).

2. LISTE DES NOMS

Les épithètes de noms infragénériques sont supposées combinées dans le genre *Lactarius*, sauf indication contraire. (rappel: les epithètes invalides sont en *italiques*)

Genre (G)

Lactarius Pers. 1797, Tent. Disp. Meth. Fung.: 63 ("Lactaria"), nom. cons. (cf. Taxon 37: 456, 1988), LT (Earle 1909): L. piperatus (L.: Fr.) Pers. (≡ Agaricus piperatus L.: Fr.)
≡ **Galorrheus** (Fr.: Fr.) Fr. 1825, Syst. Orb. veget.: 75, LT (Donk 1949): A. piperatus L.: Fr.
≡ **Lactifluus** (Pers.) Roussel 1806, Fl. Calvados, 2ème éd.: 66, LT (Earle 1909): A. piperatus L.: Fr.
= **Hypophyllum** Paulet emend. Earle 1909, T (incorrect, méthode de désignation mécanique – Art.10.5b/Tokyo): Lactarius rufus (Scop.: Fr.) Fr. [non Hypophyllum Paulet 1808, Prospectus du Traité des champignons: 43, LT: Agaricus campestris L.: Fr. (**désign. ici même**)]
= **Lactariella** Schröter 1889 in Cohn, Krypt.-Fl. Schlesien, Pilze 3: 544, LT (Earle 1909): L. fuliginosus (Fr.: Fr.) Fr.
= **Lactariopsis** Henn. 1901, Bot. Jahrb. Syst. 30: 51, HT: Lactariopsis zenkeri Henn.
= **Gloeocybe** Earle 1909, Bull. New York Bot. Gard. 5: 409, HT: L. insulsus (Fr.: Fr.) Fr.
= **Pleurogala** Redhead & Norvell 1993, Mycotaxon 48: 377, T: L. panuoides Singer (genre synonyme selon certains auteurs)

Sous-genres (SG)

Colorati (Bataille) Bon 1983, Doc. Mycol. 13(50): 21, T: L. glyciosmus (Fr.: Fr.) Fr.
Lactariopsis (Henn.) R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 36, HT: L. zenkeri (Henn.) Singer
Lactarius. Autonyme (T: L. piperatus)
Lactiflui (Burl.) Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 158 ("Lactifluus" et "type = L. volemus"), T (automatique): L. lactifluus (L.) Quél.
Piperites (Fr. ex J. Kickx f.) Kauffman, Agaricaceae of Michigan I: 88 (1918), LT (Hesler & A.H. Sm. 1979): L. torminosus (Schaeff.: Fr.) Pers.
Plinthogali (Burl.) Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 99, ("Plinthogalus" et "type = L. lignyotus"), T (automatique): L. plinthogalus (J. Otto) Burl.
Rhysocybe Neuhoff ex Bon 1979, Doc. Mycol. 10(37-38): 92, T: L. volemus (Fr.: Fr.) Fr.
Rhysocybella Bon 1983, Doc. Mycol. 13(50): 18, T: L. obscuratus (Lasch: Fr.) Fr.
Russularia (Fr. ex Burl.) Kauffman 1918, Agaricaceae of Michigan I: 105, LT (Hesler & A.H. Sm. 1979): L. subdulcis (Pers.: Fr.) Gray
Tristes Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 320, T: L. maculosus Murrill
Venolactarius R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 31 (n. inval., DL = 0), PT: L. adhaerens (n. inval.)

Sections (SC)

Albati (Bataille) Singer 1942, Ann. Mycol. 40: 109 (“Albati Quél.”), LT (Singer 1951, antidatant L. piperatus par Bon 1989): L. vellereus (Fr.: Fr.) Fr.

Allardii Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 207, T: L. allardii Coker

Aspidei (Burl.) Hesler & A.H. Sm. 1979 (“Aspideini”), North Amer. Species Lactarius: 225, T (automatique): L. aspideus (Fr.: Fr.) Fr.

Atroviridi Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 219, T: L. atroviridis Peck

Caperati R. Heim 1955, Bull. Jard. Bot. Etat. 25: 12, 16 (n. inval., DL = 0), PT: ?

Chamaeleontini Verbeken 1998, Mycotaxon 66: 393, T: L. chamaeleontinus R. Heim

Colorati (Bataille) Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 398, LT: (Hesler & A.H. Sm. 1979): L. glyciosmus (Fr.: Fr.) Fr.

Compacti R. Heim 1955, Bull. Jard. Bot. Etat. 25: 61 (n. inval., DL = 0), PT: ?

Crocei (Burl.) A.H. Sm. & Hesler 1960b, Brittonia 12: 326 (“Croceae”), T (automatique): L. croceus Burl.

Dapetes (Fr. ex J. Kickx f.) Burl. 1908, Mem. Torrey Bot. Club 14: 14-15, LT (Singer 1951): L. deliciosus (L.: Fr.) Gray

Deliciosi Fr. 1821, Syst. mycol. 1: 65: Fr. (Agaricus sect.), T (automatique): Agaricus deliciosus L.: Fr.

≡ **Deliciosi** (Fr.: Fr.) Redeuilh, Verbeken & Walleyn **comb. nov.**

Dulces (R. Heim) Singer 1942, Ann. Mycol. 40: 114 (n. inval., basio. inval.), PT: L. fulgens R. Heim

Edules Verbeken 2000 in Verbeken & Walleyn, Belg. J. Bot. 132: 176 (“1999”), T: L. edulis Verbeken & Buyck

Eulactarius Neuhoff 1956, Milchlinge: 66 (n. inval., ≡ sect. Lactarius), PT: L. piperatus (L.: Fr.) Pers.

Floccosi Kühner 1953 in Kühner & Romagnesi, Flore Analytique: 472(477) (n. inval., DL = 0), PT: ?

Fumosi Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 103, T: L. fumosus Peck

Genuini R. Heim 1955, Bull. Jard. Bot. Etat. 25: 13,70 (n. inval., DL = 0), PT: ?

Glutinosi (Quél.) Bataille 1908, Fl. monogr. Astéro.: 16, T: non désigné

Gymnocarpi R. Heim ex Verbeken 1998, Mycotaxon 66: 374, T: L. gymnocarpus R. Heim ex Singer

Ichorati Bon 1979, Doc. Mycol. 10(37-38): 92, T: L. rubrocinctus Fr.

Lactariopsidei Singer 1962, Sydowia 15: 83 (“Singer ex”), HT: L. zenkeri (Henn.) Singer

Lactariopsis (Henn.) Singer 1942, Ann. Mycol. 40: 111 (“Lactariopsideae”, “Lactariopsidei” in Singer 1951), HT: L. zenkeri Henn.

Lactarius. Autonyme (T: L. piperatus)

Lactiflui (Burl.) Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 159 (“Lactifluus” et “type = L. volemus”), T (automatique): L. lactifluus (L.) Quél.

Lactifluus Pers. 1801, Syn. meth. fung.: 429 (Agaricus sect.), LT (Earle 1909): L. piperatus

Limacini Fr. 1821, Syst. mycol. 1: 65: Fr. (Agaricus sect.), T (automatique implicite = type automatique du nom alternatif Ag. sect. Deliciosi): Agaricus deliciosus L.: Fr.

Limacini Cooke 1871, Handb. Brit. Fungi 1: 209, T: non désigné
Note: Cooke a créé une sect. nov. (homonyme). Il n'a pas validé la comb. "Ag. sect. Limacini (Fr.: Fr.) Cooke" car il en exclut le type (automatique): L. deliciosus (L.: Fr.) Gray

Nigrescentes Verbeken 2000, Persoonia 17 (sous presse), T : L. melanogalus R. Heim ex R. Heim

Obscurati Bon 1980, Doc. Mycol. 10(40): 77 ("Bataille") (n. inval., DL = 0, basio. = 0), PT: L. obscuratus (Lasch: Fr.) Fr.

Olentes (Bataille) Basso 1999, Fungi Europaei 7: 580, LT (Singer 1951): L. camphoratus (Bull.: Fr.) Fr.

Panuoidei Singer 1952, Kew Bull. 7: 301, HT: L. panuoides Singer

Pelliculares R. Heim 1955, Bull. Jard. Bot. Etat. 25: 85 (n. inval., DL = 0), PT: L. pellicularis R. Heim

Phlebonemi R. Heim ex Verbeken 1998, Mycotaxon 66: 378, T: L. phlebonemus R. Heim & Gooss.-Font.

Piperati Fr. 1821, Syst. mycol. 1: 73: Fr. (Agaricus sect.), T (automatique): Agaricus piperatus L.: Fr.
≡ **Piperati** (Fr.: Fr.) Cooke 1871, Handb. Brit. Fungi 1: 210

Piperites (Fr. ex J. Kickx f.) Burl. 1908, Mem. Torrey Bot. Club 14: 14, LT (Singer 1951): L. torminosus (Schaeff.: Fr.) Pers.

Plinthogali (Burl.) Singer 1942, Ann. Mycol. 40: 123, T (automatique): L. plinthogalus (J. Otto) Burl.

Polysphaerophori Singer 1973, Beih. Sydowia 7: 106, T: L. veraecrucis Singer

Proprii Fr. 1821, Syst. mycol. 1: 73: Fr. (Agaricus sect.), T (automatique implicite = type automatique du nom alternatif Ag. sect. Piperati): Agaricus piperatus L.: Fr.

Pruinosi (Quél.) Bataille 1908, Fl. monogr. Astéro.: 16, T: non désigné

Pseudoaurantiaci (A.H. Sm.) Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 470, T: L. substriatus A.H. Sm.

Pseudofuliginosi Verbeken 2000, Persoonia 17 (sous presse), T : L. atroolivinus Verbeken & Walleyn

Pseudogymnocarpi Verbeken 1998, Mycotaxon 66: 376, T: L. gymnocarpoides Verbeken

Pseudomyxacium Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 342, T: L. kauffmanii Hesler & A.H. Sm.

Pterospori R. Heim 1955, Bull. Jard. Bot. Etat. 25: 12,45, (n. inval.), PT: ?

Rhysocybe Neuhoff 1956, Milchlinge: 73, (n. inval., DL + T = 0), PT: ?

Rhysocybella (Bon) Bon 1983, Doc. Mycol. 13(50): 18, T: L. obscuratus (Lasch: Fr.) Fr.

Rubroviolascentini (Singer) Verbeken 1998a, Mycotaxon 66: 380 ("Rubroviolascentes"), T: L. rubroviolascens R. Heim

Rugati (Pacioni & Lalli) Verbeken 1998, Mycotaxon 66: 372, T: L. rugatus Kühner & Romagn.

Ruginosi (Bon) Bon 1983, Doc. Mycol. 13(50): 20 ("Ruginosini"), T: L. pterosporus Romagn.

Russulares Fr. 1821, Syst. mycol. 1: 68: Fr. (Agaricus sect.), T (automatique implicite = type automatique du nom alternatif Ag. sect. Subdulces): Agaricus subdulcis Pers.: Fr.

Russularia Fr. ex Burl. 1908, Mem. Torrey Bot. Club 14: 14, LT (Hesler & A.H. Sm. 1979): L. subdulcis (Pers.: Fr.) Gray

Scrobiculus Hesler & A.H. Sm., Brittonia 12: 307 (1960), T: L. scrobiculatus (Scop.: Fr.) Fr.

Subdulces Fr. 1821, Syst. mycol. 1: 68: Fr. (Agaricus sect.), T (automatique): Agaricus subdulcis Pers.: Fr.

Sublimacina Burl. 1908, Mem. Torrey Bot. Club 14: 14, T: non désigné

Subsquamulosi Hesler & A.H. Sm . 1979, North Amer. Species Lactarius: 494, T: L. aquifluus Peck

Tabidi Bon 1980, Doc. Mycol. 10(40): 75 ("Fr.") (n. inval., DL = 0, basio. = 0), PT: L. tabidus Fr.

Theiogali Hesler & A.H. Sm. 1960, Brittonia 12: 341, T: L. theiogalus (Bull.: Fr.) Gray

Tomentosi McNabb 1971, New Zealand J. Bot. 9: 59, T: L. clarkei Cleland

Torminosi Fr. 1821, Syst. mycol. 1: 62: Fr. (Agaricus sect.), T (automatique): Agaricus torminosus Schaeff.: Fr.

≡ **Torminosi** (Fr.: Fr.) Cooke 1871, Handb. Brit. Fungi 1: 207

Tricholomoidei Fr. 1821, Syst. mycol. 1: 62: Fr. (Agaricus sect.), T (automatique implicite = type automatique du nom alternatif Ag. sect. Torminosi): Agaricus torminosus Schaeff.: Fr.

Tristes Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 372 (n. inval., DL = 0), PT: L. maculosus Murrill

Triviales Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 413, T: L. affinis Peck

Uvidi (Konrad) Bon 1979, Doc. Mycol. 10(37-38): 92 (comb. inval., basio. inval.), PT: L. uvidus (Fr.: Fr.) Fr.

Vellus Hesler & A.H. Sm. 1960, Brittonia 12: 339, T: L. subvernalis Hesler & A.H. Sm.

Velutini (Quél.) Bataille 1908, Fl. monogr. Astéro.: 16, T (automatique): L. velutinus Bertillon

Venolactarius (R. Heim) Singer 1942, Ann. Mycol. 40: 111 ("Venolactarii") (comb. inval., basio. inval.), PT: L. adhaerens R. Heim

Violaceomaculati Hesler & A.H. Sm. 1979, North Amer. Species Lactarius: 322, T: L. subpalustris Hesler & A.H. Sm.

Volemi (Konrad) Bon 1980, Doc. Mycol. 10(40): 69 (comb. inval., basio. inval.), PT: L. volemus (Fr.: Fr.) Fr.

Zonarii (Quél.) Bon 1980, Doc. Mycol. 10(40): 25 (comb. inval., basio. = 0), PT: L. zonarius (Bull.) Fr.; (id. inval. in Heilmann-Clausen et al. 1998)

Sous-sections (SSC)

Albati (Bataille) Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 188, LT (Singer 1951): L. vellereus (Fr.: Fr.) Fr.

Aspidei (Burl.) Singer 1942, Ann. Mycol. 40: 117 ("Aspideinae"), T (automatique): L. aspideus (Fr: Fr.) Fr.

Barbati (Quél.) Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 186, T: non désigné

Caerulei Hesler & A.H. Sm. 1960, Brittonia 12: 121, T: L. indigo (Schwein.) Fr.

Camphoratini Bon 1979, Doc. Mycol. 10(37-38): 92, T: L. camphoratus (Bull.: Fr.) Fr.

Claricolorini Neuhoff 1956, Milchlinge: 66 (n. inval., T = 0), PT: ?

Clarkeini McNabb 1971, New Zealand J. Bot. 9: 59, T: L. clarkei Cleland

Colorati (Bataille) Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 188, LT (Singer 1951): L. glyciosmus (Fr.: Fr.) Fr.

Crocei (Burl.) Singer 1942, Ann. Mycol. 40: 117 ("Croceini"), T (automatique): L. croceus Burl.

Deliciosini Bon & Basso 1999 in Basso, Fungi Europaei 7: 252, T: L. deliciosus (L.: Fr.) Gray

Dictyosporini Neuhoff 1956, Milchlinge: 73 (n. inval., DL + T = 0), PT: ?

Dulces Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 189 (n. inval., DL = 0), PT = ?

Epitheliosi Buyck & Courtec. 1991 in Courtec. & Buyck, Mycol. Helvetica 4: 211, T: L. epitheliosus Buyck & Courtec.

Fulgentes (R. Heim) Singer 1942, Ann. Mycol. 40: 114 ("Fulgentini") (comb. inval., basio. inval.), PT: L. fulgens R. Heim

Fuliginosi (Konrad) Singer 1951, Lilloa 22: 723 (comb. inval., basio. inval.), PT: L. fuliginosus (Fr.: Fr.) Fr.

Glabrati (Quél.) Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 186, T: non désigné

Glutinosi (Quél.) Bon 1980, Doc. Mycol. 10(40): 44 ("Glutinosini") (comb. inval., ad int.), PT: ?

Grisei (Burl.) Singer 1942, Ann. Mycol. 40: 124 ("Griseini"), T (automatique): L. griseus Peck

Helvini Singer 1942, Ann. Mycol. 40: 124 (n. inval., DL = 0), PT: L. helvus (Fr.: Fr.) Fr.

Heterosporini Neuhoff 1956, Milchlinge: 74 (n. inval., DL + T = 0)

Insulsi (Burl.) Singer 1942, Ann. Mycol. 40: 117 ("Insulsini"), T (automatique): L. insulsus (Fr: Fr.) Fr.

Lactarii Hesler & A.H. Sm. 1960, Brittonia 12: 122 (n. inval., DL = 0), PT: L. deliciosus (L.: Fr.) Gray

Lactarius. Autonyme (T: L. piperatus)

Lacunari Basso, Fungi Europaei 7: 517 (1999), T: L. lacunarum (Romagn.) ex Hora

Lactiflui (Burl.) Singer 1942, Ann. Mycol. 40: 114 ("Lactifluini"), T (automatique): L. lactifluus (L.) Quél.

Laevini (R. Heim) Singer 1942, Ann. Mycol. 40: 124 (n. inval., basio. inval.), PT: L. claricolor R. Heim

Luteoli Pacioni & Lalli 1992 in Lalli & Pacioni, Mycotaxon 44: 190, HT: L. luteolus Peck

Mitissimi Neuhoff ex Bon 1979, Doc. Mycol. 10(37-38): 92, T: L. mitissimus (Fr.: Fr.) Fr.

Obscuratini Singer 1951, Lilloa 22: 724, T: L. obscuratus (Lasch: Fr.) Fr. (validité limite)

Olentes (Bataille) Singer 1942, Ann. Mycol. 40: 124 ("Olentini"), LT (Singer 1951): L. camphoratus (Bull.: Fr.) Fr.

Pallidini, Bon & Basso 1999 in Basso, Fungi Europaei 7: 158, HT: L. pallidus Pers.: Fr.

Piperati (Fr.: Fr.) Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 189, T (automatique): L. piperatus (L.: Fr.) Pers.

Polysphaerophorini Singer 1973, Beih. Sydowia 7: 106, T: L. veraecrucis Singer

Protogriseini Singer 1942, Ann. Mycol. 40: 124 (n. inval., DL = 0), PT: ?

Pseudoaurantiaci A.H. Sm. 1960 in Hesler & A.H. Sm., Brittonia 12: 326, T: L. substriatus A.H. Sm.

Pseudotorminosi Hesler & A.H. Sm. 1960, Brittonia 12: 308, T: L. nordmanensis A.H. Sm.

Pyrogalini Singer 1942, Ann. Mycol. 40: 117 (n. inval., DL. = 0), PT: L. pyrogalus (Bull.: Fr.) Fr.

Rubroviolascentini Singer 1942, Ann. Mycol. 40: 114, HT: L. rubroviolascens R. Heim

Rufini Singer 1942, Ann. Mycol. 40: 124, (n. inval., DL = 0), PT: L. rufus (Scop.: Fr.) Fr.

Rugati Pacioni & Lalli 1992 in Lalli & Pacioni, Mycotaxon 44: 190, T: L. rugatus Kühner & Romagn.

Ruginosi Bon 1979, Doc. Mycol. 10(37-38): 92, T: L. pterosporus Romagn.

Russulares (Fr.: Fr.) Basso 1999, Fungi Europaei 7: 494, T (automatique implicite = type automatique du nom alternatif Ag. sect. Subdulces): L. subdulcis (Pers.: Fr.) Gray

Sanguifluini Bon & Basso 1999 in Basso, Fungi Europaei 7: 294, T: L. sanguifluus (Paulet: Fr.) Fr.

Scrobiculi Hesler & A.H. Sm. 1960, Brittonia 12: 310 (n. inval., DL + T = 0), PT: L. scrobiculatus (Scop.: Fr.) Fr.

Scrobiculati Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 285, T: L. scrobiculatus (Scop.: Fr.) Fr.

Serifluini Bon 1979, Doc. Mycol. 10(37-38): 92, T: L. atlanticus Bon

Striatini (R. Heim) Singer 1942, Ann. Mycol. 40: 124 (n. inval., basio. inval.), PT: L. striatus R. Heim

Subdulces (Fr.: Fr.) Singer 1951, Lilloa 22: 724 ("Subdulcini (Bataille) Singer 1942"), T (automatique): L. subdulcis (Pers.: Fr.) Gray

Subumbonatini Neuhoff 1956, Milchlinge: 71 (n. inval., DL + T = 0), PT: L. subumbonatus (?)

Triviales (Hesler & A.H. Sm.) Heilmann-Clausen & Vesterh. 1990 in Heilmann.-Cl. et al., Fungi Northern Europe 2: 24 ("Trivialini", T: "L. trivialis"), T: L. affinis Peck

Turpini Neuhoff 1956, Milchlinge: 68 (1956) (n. inval., DL + T = 0), PT: L. turpis (Weinm.) Fr.

Uvidi (Konrad) Basso 1999, Fungi Europaei 7: 187 ("Uvidini") (n. inval., basio. inval.), PT: L. uvidus (Fr.: Fr.) Fr.

Velli Hesler & A.H. Sm. 1960, Brittonia 12: 340 (n. inval., DL = 0), PT: L. subvernalis Hesler & A.H. Sm.

Versicolores Hesler & A.H. Sm. 1960, Brittonia 12: 137, T: L. salmoneus Peck

Vieti (Konrad) Singer 1942, Ann. Mycol. 40: 117 ("Vietini") (n. inval., basio. inval.), PT: L. vietus (Fr.: Fr.) Fr.

Volemi Pacioni & Lalli 1992 in Lalli & Pacioni, Mycotaxon 44: 190, T: L. volemus (Fr.: Fr.) Fr.

Xanthydrorheini Singer 1951, Lilloa 22: 723 (n. inval., DL = 0), PT: L. xanthydrorheus Singer

Zonarii (Quél.) Basso 1999, Fungi Europaei 7: 330, T (automatique): L. zonarius (Bull.) Fr.

Séries (SR)

Acres A.H. Sm. & Hesler 1962, Brittonia 14: 387, T: L. acris (Bolton: Fr.) Gray

Gerardii A.H. Sm. & Hesler 1962, Brittonia 14: 378, T: L. gerardii Peck
Lactarius. Autonyme (T: L. piperatus)
Nigroviolascentes A.H. Sm. & Hesler 1962, Brittonia 14: 376, T: L. nigroviolascens G.F. Atk.
Plinthogali A.H. Sm. & Hesler 1962, Brittonia 14: 388, T: L. lignyotus Fr.

Subséries (SSR)

Fuliginosi A.H. Sm. & Hesler 1962, Brittonia 14: 411, T: L. fuliginosus (Fr.: Fr.) Fr.
Lactarius. Autonyme (T: L. piperatus)
Plinthogali A.H. Sm. & Hesler 1962, Brittonia 14: 390 (n. inval., DL = 0), PT: L. lignyotus Fr.

Stirpes (ST)

Argillaceifolius Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 364 (n. inval., DL = 0), PT: L. argillaceifolius Hesler & A.H. Sm.
Aspideus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 231 (n. inval., DL = 0), PT: L. aspideus (Fr.: Fr.) Fr.
Bertillonii Bon 1980, Doc. Mycol. 10(40): 17 (n. inval., DL = 0), PT: L. bertilloni (Neuhoff ex Z. Schaef.) Bon
Blennius Singer 1951, Lilloa 22: 726 (n. inval., DL = 0), PT: L. blennius (Fr.: Fr.) Fr.
Chrysorrheus Singer 1951, Lilloa 22: 726 (n. inval., DL = 0), PT: L. chrysorrheus Fr.
Circellatus Bon 1980, Doc. Mycol. 10(40): 40 (n. inval., DL = 0), PT: L. circellatus Fr.
Deceptivus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 192 (n. inval., DL = 0), PT: L. deceptivus Peck
Fulvissimus Bon 1980, Doc. Mycol. 10(40): 60 (n. inval., DL = 0), PT: L. fulvissimus Romagn.
Glutinopallens Bon 1980, Doc. Mycol. 10(40): 47 (n. inval., DL = 0), PT: L. glutinopallens F.H. Möller & J.E. Lange
Hygrophoroides Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 169 (n. inval., DL = 0), PT: L. hygrophoroides Berk. & M.A. Curtis
Hysginus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 427 (n. inval., DL = 0), PT: L. hysginus (Fr.: Fr.) Fr.
Indigo Bon 1980, Doc. Mycol. 10(40): 28 (n. inval., DL = 0), PT: L. indigo (Schwein.) Fr.
Insulsus Singer 1951, Lilloa 22: 726 (n. inval., DL = 0), PT: L. insulsus (Fr.: Fr.) Fr.
Maculosus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 379 (n. inval., DL = 0), PT: L. maculosus Murrill
Mucidus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 348 (n. inval., DL = 0), PT: L. mucidus Burl.
Necator Singer 1951, Lilloa 22: 726 (n. inval., DL = 0), PT: L. necator (Bull.: Fr.) P. Karst.
Pyrogalus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 373 (n. inval., DL = 0), PT: L. pyrogalus (Bull.: Fr.) Fr.
Sanguifluus Bon 1980, Doc. Mycol. 10(40): 28 (n. inval., DL = 0), PT: L. sanguifluus (Paulet: Fr.) Fr.
Scrobiculatus Singer 1962, AMT 2: 787 (n. inval., DL = 0), PT: L. scrobiculatus

(Scop.: Fr.) Fr.

Speciosus Hesler & A.H Sm.1979, North Amer. Species Lactarius: 225 (n. inval., DL = 0), PT: L. speciosus Burl.

Subdulcis Bon 1980, Doc. Mycol. 10(40): 57 (n. inval., DL = 0), PT: L. subdulcis (Pers.: Fr.) Gray

Subvellereus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 197 (n. inval., DL = 0), PT: L. subvellereus Peck

Torminosus Singer 1951, Lilloa 22: 726 (n. inval., DL = 0), PT L.: L. torminosus (Schaeff.: Fr.) Pers.

Trivialis Singer 1951, Lilloa 22: 726 (n. inval., DL = 0), PT: L. trivialis (Fr.: Fr.) Fr.

Vellereus Bon 1980, Doc Mycol. 10(40): 16 (n. inval., DL = 0), PT: L. vellereus (Fr.: Fr.) Fr.

Vietus Hesler & A.H. Sm.1979, North Amer. Species Lactarius: 384 (n. inval., DL = 0), PT: L. vietus (Fr.: Fr.) Fr.

Rang infragénérique indéfini

Notes (1) Les noms valides originaux de cette catégorie sont à prendre en compte pour les questions d'homonymie et ils peuvent servir de basionyme. Ils ne peuvent cependant pas entrer en compétition contre d'autres noms qui seraient à un rang bien déterminé.

(2) Les noms valides de rang inférieur à tribu dans l'Epicrisis de Fries (1838), de même que dans la Monographia (1863) et dans les Hymenomycetes Europaei (1874), sont considérés comme étant de rang indéfini et non des sections.

Acerrimi J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 25 (1928), T (automatique): L. acerrimus Britzelm.

Acres Bataille 1908, Fl. monogr. Astéro.: 41, T (automatique): L. acris (Bolton: Fr.) Gray (var. ortho. "Acri": 16)

Agglutinati Burl. 1908, Mem. Torrey Bot. Club 14: 40, ("Agglutinatae"), T (automatique): L. agglutinatus Burl.

Albati Bataille 1908, Fl. monogr. Astéro.: 35, LT (Singer 1951): L. vellereus (Fr.: Fr.) Fr. (variante orthogr. "Albatae" in Lange 1928)

Aspidei Burl. 1908, Mem. Torrey Bot. Club 14: 46 ("Aspideae"), T (automatique): L. aspideus (Fr.: Fr.) Fr.

Aurantiofulvi J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 24, T (automatique): L. aurantiofulvus J. Blum ex Bon

Barbati Quél. 1888, Fl. mycol. France: 354 , T: non désigné

Camphorati Burl. 1908, Mem. Torrey Bot. Club 14: 97 ("Camphoratae"), T (automatique): L. camphoratus (Bull.: Fr.) Fr.

Candidi Bataille 1908, Fl. monogr. Astéro.: 40, T: non désigné

Chrysorrhei Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 187 (n. inval., DL. = 0), PT: L. chrysorrheus Fr.

Cinerei Burl. 1908, Mem. Torrey Bot. Club 14: 66 ("Cinereae"), T (automatique): L. cinereus Peck

Colorati Bataille 1908, Fl. monogr. Astéro.: 36, LT (Hesler & A.H. Sm. 1979): L. glyciosmus (Fr.: Fr.) Fr.

Compacti Bataille 1908, Fl. monogr. Astéro.: 35, T: non désigné

Compacti R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 160, (n. inval., DL = 0), PT: ?

Constantes Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 189 (n. inval., DL. = 0), PT: L. helvus (Fr.: Fr.) Fr.

Crocei Burl. 1908, Mem. Torrey Bot. Club 14: 37 ("Croceae"), T (automatique): L. croceus Burl.

Cruenti Bataille 1908, Fl. monogr. Astéro.: 28, T: non désigné

Cyathiformes Quél. 1888, Fl. mycol. France: 358, T: non désigné

Dapetes Fr. 1863, Monographia 2: 168 (n. inval., rang tribu incorrect), PT: ?

Dapetes Fr. ex J. Kickx f. 1867 in J.J. Kickx, Fl. crypt. Flandres II: 201, LT (Singer 1951): L. deliciosus (L.: Fr.) Gray

Deliciosi Burl. 1908, Mem. Torrey Bot. Club 14: 57 ("Deliciosae"), T (automatique): L. deliciosus (L.: Fr.) Gray

Discolorantes J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 24 (1928), T: non désigné

Dulces R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 160 (n. inval., DL = 0), PT: L. fulgens (n. inval.)

Eulactarius J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 23 (n. inval., préfixe Eu- interdit), PT: L. piperatus

Floccosi Kühner 1953 in Kühner & Romagn., Fl. Anal.: 472 (n. inval., DL = 0), PT: ?

Fucati Bataille 1908, Fl. monogr. Astéro.: 41, T: non désigné ?

Fulgentes R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 160 (n. inval., DL = 0), PT: L. fulgens (n. inval.)

Fuliginosi Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 188 (n. inval., DL = 0), PT: L. fuliginosus (Fr: Fr.) Fr.

Galorrheus Fr. 1821, Syst. mycol. 1: 61: Fr. (sub "Agaricus tribus Galorrheus"), LT (Donk 1949): L. piperatus

Glabrati Bataille 1908, Fl. monogr. Astéro.: 28, T: non désigné

Glutinosi Quél. 1888, Fl. mycol. France: 351, T: non désigné

Grisei Burl. 1908, Mem. Torrey Bot. Club 14: 80 ("Griseae"), T (automatique): L. griseus Peck

Gymnocarpi R. Heim 1955, Bull. Jard. Bot. Etat 25: 24 (n. inval., DL = 0), PT: L. gymnocarpus R. Heim ex Singer

Helvi Burl. 1908, Mem. Torrey Bot. Club 14: 74 ("Helvae"), T (automatique): L. helvus (Fr.: Fr.) Fr.

Immutabiles J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 24, T: non désigné

Inamoeni J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 25, T: non désigné

Ingrati R. Heim 1955, Bull. Jard. Bot. Etat. 25: 64, (n. inval., DL = 0), PT: L. corbula R. Heim & Gooss.-Font.

Inolentes Bataille 1908, Fl. monogr. Astéro.: 42, T: non désigné

Insulsi Burl. 1908, Mem. Torrey Bot. Club 14: 50 ("Insulsae"), T (automatique): L. insulsus (Fr.: Fr.) Fr.

Lactiflui Burl. 1908, Mem. Torrey Bot. Club 14: 89 ("Lactifluae"), T (automatique): L. lactifluus (L.) Quél.

Lactariopsis (Henn.) R. Heim 1955, Bull. Jard. Bot. Etat 25: 16, PT: L. zenkeri (Henn.) Singer

Lactifluus (Agaricus "familia") Pers. 1800, Comment. Schaeff. (: x) (n. inval., rang infragen. familia incorrect), PT: ?

Lactosi Bataille 1908, Fl. monogr. Astéro.: 29, T: non désigné

Laevini R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 161 (n. inval., DL = 0), PT: L. claricolor (n. inval.)

Lanati Bataille 1908, Fl. monogr. Astéro.: 25, T: non désigné

Lateripedes Fr. 1838, Epicr.: 348 (n. inval., rang tribu incorrect), PT: ?

Limacini (Fr.: Fr.) Fr. 1838, Epicr.: 336, T (automatique implicite = type automatique du nom alternatif Ag. sect. Deliciosi): L. deliciosus (L.: Fr.) Gray

Nigricantini R. Heim 1955, Bull. Jard. Bot. Etat. 25: 61 (n. inval., DL = 0), PT: ?

Olentes Bataille 1908, Fl. monogr. Astéro.: 44, LT (Singer 1951): L. camphoratus (Bull.: Fr.) Fr.

Phlebonemi R. Heim 1955, Bull. Jard. Bot. Etat. 25: 16 (n. inval., DL = 0), PT: ?

Piperati Fr. 1838, Epicr.: 338, T (automatique): Agaricus piperatus L.: Fr.

Piperati R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 160 (n. inval., DL = 0), PT: L. piperatus

Piperites Fr. 1838, Epicr.: 333 (n. inval., rang tribu incorrect), PT: ?

Piperites Fr. ex J. Kickx f. 1867 in J.J. Kickx, Fl. crypt. Flandres II: 199, T: non désigné

Pleuropus Quél. 1886, Enchir.: 132, T: non désigné

Plinthogali Burl. 1908, Mem. Torrey Bot. Club 14: 83 ("Plinthogalae"), T (automatique): L. plinthogalus (J. Otto) Burl.

Pruinosi Quél. 1888, Fl. mycol. France: 358, T: non désigné

Pseudoalbati Bon 1980, Doc. Mycol. 10(40): 18 (n. inval., ad int.), PT: ?

Quieti Burl. 1908, Mem. Torrey Bot. Club 14: 62 ("Quietae"), T (automatique): L. quietus (Fr.: Fr.) Fr.

Russulares (Fr.: Fr.) Fr. 1838, Epicr.: 341 (n. inval., rang tribu incorrect), PT: Agaricus subdulcis Pers.: Fr.

Russularia Fr. 1874, Hym. Eur.: 431 (n. inval., rang tribu incorrect), PT: Agaricus subdulcis Pers.: Fr.

Rusticani Burl. 1908, Mem. Torrey Bot. Club 14: 27 ("Rusticanae"), T (automatique): L. rusticanus (Scop.) Burl.

Serifluentes J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 25, T (automatique): L. serifluus (DC.: Fr.) Fr.

Squamosi, R. Heim 1962, Rev. Mycol. (Paris) 27: 141 (n. inval., DL = 0), PT: L. purpureus (n. inval.)

Striatini R. Heim 1938, Prodr. Fl. mycol. Madagascar 1: 161 (n. inval., DL = 0), PT: L. striatus (n. inval.)

Subdulces (Fr.: Fr.) Bataille 1908, Fl. monogr. Astéro.: 42 ("Subdulci"), T (automatique): L. subdulcis (Pers.: Fr.) Gray

Tenuiores Bataille 1908, Fl. monogr. Astéro.: 36, T: non désigné

Theiogali Burl. 1908, Mem. Torrey Bot. Club 14: 69 ("Theiogalae"), T (automatique): L. theiogalus (Bull.: Fr .) Gray

Tomentosi Bataille 1908, Fl. monogr. Astéro.: 26, T: non désigné

Torminosi (Fr.: Fr.) Burl. 1908, Mem. Torrey Bot. Club 14: 29 ("Torminosae"), T (automatique): L. torminosus (Schaeff.: Fr.) Pers.

Tricholomoidei (Fr.: Fr.) Fr. 1838, Epicr.: 333, T (automatique implicite = type automatique du nom alternatif Ag. sect. Torminosi): Agaricus torminosus Schaeff.: Fr.

Triviales Burl. 1908, Mem. Torrey Bot. Club 14: 53, T (automatique): L. trivialis (Fr.: Fr.) Fr.

Truncigeni Fr. 1838, Epicr.: 348 ("Truncigenae"), T: non désigné
Umbonati Quél. 1888, Fl. mycol. France: 359, T: non désigné
Uvidi Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 186 (n. inval., DL = 0), PT: L. uvidus (Fr.: Fr.) Fr.
Velati Bataille 1908, Fl. monogr. Astéro.: 25, T: non désigné
Velutini Quél. 1888, Fl. mycol. France: 362, T (automatique): L. velutinus Bertillon
Versatiles Quél. 1888, Fl. mycol. France: 351, T: non désigné
Versicolores J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 23, T: non désigné
Vestiti J.E. Lange 1928, Dansk Bot. Arkiv 5(5): 25, T: non désigné
Vieti Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 187 (n. inval., DL = 0), PT: L. vietus (Fr.: Fr.) Fr.
Volemi Konrad 1935, Bull. Trim. Soc. Mycol. France 51: 190 (n. inval., DL = 0), PT: L. volemus (Fr.: Fr.) Fr.
Zonarii Quél. 1888, Fl. mycol. France: 355, T (automatique): L. zonarius (Bull.) Fr.

3. LISTE DES TYPES (NOMS DE RANG DEFINI SEULEMENT)

(Les épithètes sont combinées dans les genres *Lactarius* ou *Agaricus*)

acris: SR Acres. adhaerens: SG *Venolactarius*, SC *Venolactarius*. affinis: SC Triviales, SSC Triviales. allardii: SC Allardii. aquifluus: SC Subsquamulosi. argillaceifolius: ST *Argillaceifolius*. aspideus: SC Aspidei, SSC Aspidei, ST *Aspideus*. atlanticus: SSC Serifluini. atroolivinus : SSC Pseudofuliginosi. atroviridis: SC Atroviridi. bertillonii: ST *Bertillonii*. blennius: ST *Blennius*. camphoratus: SC Olentes, SSC Olentes, Camphoratini. chamaeleontinus: SC Chamaeleontini. chrysorheus: ST *Chrysorrheus*. circellatus: ST *Circellatus*. claricolor: SSC *Laevini*. clarkei: SC Tomentosi, SSC Clarkeini. croceus: SC Crocei, SSC Crocei. deceptivus: ST *Deceptivus*. deliciosus: SC Dapetes, Deliciosi, Limacini ; SSC Deliciosini, *Lactarii*. edulis: SC Edules. epitheliosus: SSC Epitheliosi. fulgens: SC *Dulces*, SSC *Fulgentes*. fuliginosus: G Lactariella, SSC *Fuliginosi*, SSR Fuliginosi. fulvissimus: ST *Fulvissimus*. fumosus: SC Fumosi. gerardii: SR Gerardii. glutinopallens: ST *Glutinopallens*. glyciosmus: SG Colorati, SC Colorati, SSC Colorati. griseus: SSC Grisei. gymnocarpoides: SC Pseudogymnocarpi. gymnocarpus: SC Gymnocarpi. helvus: SSC *Helvini*. hygrophoroides: ST *Hygrophoroides*. hysginus: ST *Hysginus* indigo: SSC Caerulei, ST *Indigo*. insulsus: G Gloeocybe, SSC Insulsi, ST *Insulsus* kauffmanii: SC Pseudomyxacium. lactifluus: SG Lactiflui, SC Lactiflui, SSC Lactiflui. lacunarum: SSC Lacunari. lignyotus: SR Plinthogali, SSR *Plinthogali*. luteolus: SSC Luteoli. maculosus: SG Tristes, SC *Tristes*, ST *Maculosus*. melanogalus: SC Nigrescentes. mitissimus: SSC Mitissimi. mucidus: ST *Mucidus*. necator: ST *Necator*. nigroviolascens: SR Nigroviolascentes. nordmanensis: SSC Pseudotorminosi. obscuratus: SG Rhysocybella, SC Rhysocybella, *Obscurati*, SSC Obscuratini. pallidus: SSC Pallidini. panuoides: G Pleurogala, SC Panuoidei. pellicularis: SC *Pelliculares*. phlebonemus: SC Phlebonemi. plinthogalus: SG Plinthogali, SC Plinthogali. piperatus: G Galorrheus, Lactarius, Lactifluus, SG Lactarius, SC *Eulactarius*, Lactarius, Lactifluus, Piperati, Proprii, SSC Lactarius, Piperati, SR Lactarius, SSR Lactarius. pterosporus: SC Ruginosi, SSC Ruginosi. pyrogalus: SSC *Pyrogalini*, ST *Pyrogalus*. rubrocinctus: SC Ichorati. rubroviolascens: SC Rubroviolascentini, SSC Rubroviolascentini. rufus: SSC *Rufini*.

rugatus: SC Rugati, SSC Rugati. salmoneus: SSC Versicolores. sanguifluus: SSC Sanguifluini, ST *Sanguifluus*. scrobiculatus: SC Scrobiculus, SSC *Scrobiculi*, Scrobiculati, ST *Scrobiculatus*. speciosus: ST *Speciosus*. striatus: SSC *Striatini*. subdulcis: SG Russularia, SC Russularia, Russulares, Subdulces, SSC Russulares, Subdulces, ST *Subdulcis*. subpalustris: SC Violaceomaculati. substriatus: SC Pseudoaurantiaci, SSC Pseudoaurantiaci. subvellereus: ST *Subvellereus* subvernalis: SC Vellus, SSC *Velli*. tabidus: SC *Tabidi*. theiogalus: SC Theiogali. torminosus: SG Piperites, SC Piperites, Torminosi, Tricholomoidei, ST *Torminosus*. trivialis: ST *Trivialis* turpis: SSC *Turpini*. uvidus: SC *Uvidi*, SSC *Uvidi*. vellereus: SC Albati, SSC Albati, ST *Vellereus*. velutinus: SC Velutini. veraecrucis: SC Polysphaerophori, SSC Polysphaerophorini. vietus: SSC *Vieti*, ST *Vietus*. volemus: SG Rhysocybe, SC *Volemi*, SSC Volemi. xanthydrorheus: SSC *Xanthydrorheini*. zenkeri: G Lactariopsis, SG Lactariopsis, SC Lactariopsis, Lactariopsidei. zonarius: SC *Zonarii*, SSC Zonarii.

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NOMENCLATURAL AND TAXONOMIC REVISIONS IN THE MELIOLACEAE

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Abstract

New names are proposed for: 1. *Amazonia psychotriae* var. *major* (Gaillard) Hansf. (1961), a later homonym of var. *major* Hansf. (1954), and 2. *Meliola castanopsidis* Budathoki & P.N. Singh (1994), a later homonym of *M. castanopsis* Hansf. (1948). - 3. A comb. nov. at species rank is needed under *Irenopsis* for *Meliola aciculosa* var. *verbenae*.- 4. A new species of *Meliola* is recognized, typified by a specimen erroneously cited as a paratype of *Irene cubitella*.- 5. The name *Meliola combinans* Cif. is validated and lectotypified, and lectotypes are designated for 6. *Asteridiella glabra* var. *isertiae*, and 7. *Meliola galopinae*.- 8. Correction is needed for the host name cited for *Meliola chasaliae*.- 9. The nomenclature of *Meliola evansii* and *M. scolopiae* is reassessed, and two varietal names are transferred to *M. evansii*. - 10. A new name is provided for *M. evansii* sensu auct. non Doidge (1920).- 11. The sanctioned name *Meliola psidii* is conserved over the earlier synonym *M. trichostroma*, and two varieties published under the latter species name require transfer to *M. psidii*.

Keywords: *Amazonia, Asteridiella, Irenopsis, Meliola*

1. *Amazonia psychotriae* (Henn.) Theiss. var. ***hansfordiana*** J.L. Crane & A.G. Jones, nom. nov.
≡*Amazonia psychotriae* (Henn.) Theiss. var. *major* (Gaillard) Hansf., Beih. Sydowia 2:575. 1961, nom. illegit. [typified by Thollon No. 256 (PC)], non *A. psychotriae* var. *major* Hansf., Reinwardtia 3:102. 1954 [typified by Boedijn No. 1688 (BO 13021)].
≡*Meliola asterinoides* G. Winter var *major* Gaillard, Le Genre *Meliola*, p. 58. 1892 (basionym: typified by Thollon No. 256).
Type: On Rubiaceae sp. indet. Congo Française (= Republ. of Congo), leg. Thollon No. 256 (Assumed holotype: PC).

Although Gaillard's (1892) varietal name has priority, it cannot be used because it is unavailable under the current species name (Art. 58 of I.C.B.N).

2. *Meliola castanopsicola* J.L. Crane & A.G. Jones, nom. nov.

≡*Melola castanopsidis* Budathoki & P.N. Singh, Indian Phytopathol. 47(4):377. 1994, nom. illegit., non *M. castanopsis* Hansf., Farlowia 3(3):275. 1948 (as *castanopsidis).*

Type: "In foliis vivis *Castanopsidis indicae*" = *Castanopsis indica* (Roxb. ex Lindl.) A. DC. in Hance (Fagaceae). Nepal, Godavari, Kathmandu Valley, Nov. 1985; leg. Budathoki (Holotype: KU 77, Isotype: IMI 304423).

3. *Irenopsis verbenae* (Cif.) J.L. Crane & A.G. Jones, comb. nov.

≡*Meliola (Irenopsis) aciculosa* G. Winter var. *verbenae* Cif., Mycopathologia 7:89. 1954.

≡*Meliola verbenae* (Cif.) Cif., Atti Ist. Bot. Lab. Crittog. Univ. Pavia. Serie 5, 19:135. 1962.

Type: On *Verbena domingensis* Urban (Verbenaceae), Dominican Republic, Cordillera Central, Prov. La Vega, 30 Oct. 1920, leg. E.L. Ekman No. 3161 (not seen).

Hansford (1961) agreed with Ciferri that the species should be referred to *Irenopsis*, but he did not formally make the transfer. Although we have been, so far, unable to locate type material, we think that the species is best placed in *Irenopsis* F. Stevens. This placement is supported by the Beeli formula.

4. *Meliola austro-americana* J.L. Crane & A.G. Jones, sp. nov.

≡*Irenina cubitella* F. Stevens, Ann. Mycol. 25:461. 1927 [typified by F. Stevens No. 193 (ILL 3927)], non *Irene cubitella* F. Stevens & Tehon, Mycologia 18:18. 1926 [typified by F. Stevens No. 119 (Holotype: ILL 3926)].

Misapplied name:*Meliola cubitella* sensu Hansford., Beih. Sydowia 2:249. 1961 [typified by F. Stevens No. 193 (ILL 3927)], non *Irene cubitella* F. Stevens & Tehon, Mycologia 18:18. 1926, nec *Meliola cubitella* (F. Stevens & Tehon) Cif. Mycopathologia 7:87. 1954, nom. inval. [Art. 33.2. of I.C.B.N.; typified by F. Stevens No. 119 (Holotype: ILL 3926)].

Coloniae hypophyllae ad 10mm diam., tenues. Hyphae curvatae, ramosae oppositae vel irregulares ad angulos latos, laxe intertexae-reticulatae, cellulis plerumque 15–30 × 5–6μm. Hyphopodia alterna vel ad 4% opposita, expansa, insolenter recta, 9–17μm longa; cellulae basales cylindraceae vel cuneatae, 2–8μm longae; cellulae apicales globosae versus ovatas, integerae, 7–11 × 5–7μm. Phialides mixtae hyphopodis, alternae vel rare oppositae, ampulliformes, 15–20 × 5–7μm. Setae myceliales tenuiter dispersae, ad 240 × 7–8μm, simplices, super amplificatas et diverse tortae versus contortae, obtusae. Perithecia dispersa, leviter verrucosa, ad 120μm diam. Ascosporae oblongae, obtusae, 4- septatae, constricta 28–35 × 11–13μm.

Colonies hypophyllous, to 10mm in diam., thin. Hyphae crooked, branched opposite or irregular at wide angles, loosely interwoven-reticulate, cells mostly 15–30× 5–6μm. Hyphopodia alternate or to 4% opposite, spreading, usually straight, 9–17μm long; stalk cells cylindric or cuneate, 2–8μm long;

apical cells globose to ovate, entire, 7–11× 5–7µm. Phialides mixed with hyphopodia, alternate or rarely opposite, ampulliform, 15–20× 5–7µm. Mycelial setae thinly scattered, to 240 × 7–8µm, simple, enlarged above and variously twisted to contorted, obtuse. Perithecia scattered, slightly verrucose, to120µm in diam. Ascospores oblong, obtuse, 4-septate, constricted, 28–35 × 11–13µm.
Holotype: On *Cassia* sp. (Fabaceae, subf. Caesalpinioideae), Guyana, Tumatumari, 11 July 1922, leg. F. Stevens 193, ILL 3927!
Illustration: C.G. Hansford, 1963. Fig. 561 (as *Meliola cubitella*).

5. ***Meliola combinans*** Cif. ex J.L. Crane & A.G. Jones (sp. nov. validated and accepted).
≡*Meliola combinans* Cif., n. sp. ad interim. Sydowia 10:136. (1956) 1957, nom. inval. [Art. 34.1 of I.C.B.N.].
Type: On *Pharus* sp. (Poaceae). Republica Dominicana, Cordillera Septentrional, prov. Puerto Plata, road to town, 6 Aug.1931, leg. Ciferri, Mycoflora Domingensis Exsiccata No. 339 (**Lectotype designated herein**: ILL 33108!).

Ciferri (1954) provided an extensive Latin description and a type citation, but apparently no holotype was designated. We lectotypified the name with a packet located at ILL, containing ample material, and marked "Part of the type."

6. *Asteridiella glabra* (Berk. & M.A. Curtis) Hansf. ex Hansf. var. *isertiae* (F. Stevens) Hansf., Beih. Sydowia 2:579. 1961.
≡*Irenina isertiae* F. Stevens, Ann. Mycol. 25:460, pl. 2, fig. 20. 1927.
Type: On *Isertia haenkeana* DC. (Rubiaceae); the specimen label marked as host "unknown." Panama (Canal Zone): Fort Sherman, Sweetwater, 6 Oct. 1924, leg. F. Stevens No. 1092 (**Lectotype designated herein**: ILL 4107!).

Stevens (1927) listed 12 syntypes in the protologue of *Irenina isertiae*. Most of the host plants were identified as *Isertia haenkeana* DC. Although Hansford annotated all the packets, neither he nor, as far as we know, any other author publishing on Meliolaceae has lectotypified this name. We chose F. Stevens No. 1092 (ILL 4107) because Stevens used the specimen for the published illustration (pl. 2, fig. 20). Fortunately, we were able to identify the ample material in the packet of ILL 4107 (including also two microscopic slides presumably prepared by Stevens) as belonging in *I. haenkeana* along with most of the other specimens.

7. *Meliola galopinae* Hansf., Sydowia 10:73. (1956) 1957.
Type: As "*Meliola microspora* Pat. & Gaillard;" on *Galopina circaeoides* Thunb. (Rubiaceae). South Africa: Woodbush, Helpmakaar, Zoutpansberg, 3 Aug. 1911, leg. E.M. Doidge No. 1760 (**Lectotype designated herein**: PREM 1760, Isolectotype: ILL 5646!).

Five syntypes are listed in the protologue. We selected the first number of the list because a specimen is on deposit at ILL which was examined by Hansford. He annotated the packet in 1956 as *M. psychotriae* Earle. Doidge (1950) had first suggested placement under the latter name of all the syntypes subsequently cited by Hansford for *M. galopinae*.

8. *Meliola chasaliae* Mibey in Mibey & D. Hawksw., Mycol. Pap. 174:38. 1997.
Type: on leaves and petioles of *Chazaliella abrupta* (Hiern) E. Petit & Verdcourt [cited as *Chasalia abrupta* (sic!)], Kenya, Shimba Hills National Reserve, montane forest, 6 Sep. 1993, leg. R.K. Mibey (Holotype: IMI 367364, Isotype: NAI 793).

In the protologue, Mibey in Mibey & Hawksworth (1997) cited the host name of *Meliola chasaliae* as *Chasalia abrupta* (nomen). This combination was never made in *Chassalia* Comm. ex Poiret or in *Chasalia* DC. (an orthographic variant of the former generic name). The correct name is *Chazaliella abrupta* (Hiern) E. Petit & Verdcourt (basionym: *Psychotria abrupta* Hiern); i.e., the author of the fungus name misread the host name. We have been advised that the misleading specific epithet of the fungus name, unfortunately, cannot be corrected as an "orthographic error" under Rec. 60H of ICBN.

9. Reassessment of the nomenclature of *Meliola evansii* Doidge (1920) and *M. scolopiae* Doidge in Doidge & Sydow (1928).

Meliola evansii was described by Doidge (1920), based on three syntypes, the hosts all thought to be members of Celastraceae (order Celastrales). 1: leg. Pole Evans, PREM 9067, on an unidentified host (cited as "in foliis *Celastrineae* cujusdam"); 2: leg. G.W. Davies, PREM 11237, as *Mystroxylon eucleaeforme* Ecklon & Zeyher, the host identification changed in Doidge (1950) to *Pterocelastrus tricuspidatus* (Lam.) Sonder (a different species in Celastraceae); and 3: leg. O'Connor, PREM 10222, on *Cassine eucleiformis* (Ecklon & Zeyher) O. Kuntze (cited in the protologue as basionym: *Mystroxylon eucleaeforme* Ecklon & Zeyher). Stevens (1928) unfortunately selected PREM 9067 as "type" of *M. evansii*. This selection was confirmed as "Lectotype" by Crane & Jones (1997). The host of "PREM 9067" was subsequently identified by Doidge in Doidge & Sydow (1928) and Doidge (1950) as *Scolopia zeyheri* (Nees) Harvey, a member of Flacourtiaceae (order: Violales). Hansford (1961) confirmed this identification. Both authors omitted the "lectotype" from their subsequent treatments of *M. evansii* Doidge and placed the collection of PREM 9067 under *M. scolopiae* Doidge in Doidge & Sydow (1928: p. 438). Thus, *M. evansii* Doidge (1920) is an earlier name for *M. scolopiae* Doidge in Doidge & Sydow (1928: p. 467). The synonymy is as follows:

Meliola evansii Doidge, Trans. Roy. Soc. South Africa 8:112. 1920.
Type: On *Scolopia zeyheri* (Nees) Harvey (Flacourtiaceae), erroneously cited as "*Celastrineae cujusdam*" in the protologue. South Africa, Cape Prov.,

Mossel Bay, 22 Jul. 1915, leg. I.B. Pole Evans (Lectotype: PREM 9067, Isolectotype: ILL 5107).

= *Meliola scolopiae* Doidge in Doidge & Sydow, Bothalia 2(2):467. 1928.

Type: on *Scolopia zeyheri* (Nees) Harvey. South Africa, Pirie, prope Kingwilliamstown., 18 Jul. 1927, leg. E.M. Doidge (Holotype: PREM 22421).

Two varietal names published under *Meliola scolopiae* are transferred to *M. evansii* as follows:

Meliola evansii Doidge var. ***zeylanica*** (Hansf.) J.L. Crane & A.G. Jones, comb. nov.

Basionym: *Meliola scolopiae* Doidge var. *zeylanica* Hansf., Proc. Linn. Soc. London 158:35. 1947.

Type: In foliis *Scolopiae crassipedis*, Hakgala, Ceylon [Sri Lanka], Herb. Peradeniya 5208 (Holotype: PDA).

Meliola evansii Doidge var. ***indica*** (Hosag.) J.L. Crane & A.G. Jones, comb. nov.

Basionym: *Meliola scolopiae* Doidge var. *indica* Hosag., Meliolales of India p. 307. 1996.

Type: On leaves of *Scolopia crenata* (Flacourtiaceae), Veerapuli Reserve Forest, Kanniyakumari Dist., Tamil Nadu [India], 22 Feb. 1994, leg. Hosagoudar (Holotype: HCIO 41616).

A new name is provided for *M. evansii* sensu Doidge & Sydow (1928), Doidge (1950), and sensu Hansford (1961), non Doidge (1920), as represented by the emended description in Hansford (1961).— See next:

10. *Meliola pterocelastri* J.L. Crane & A.G. Jones, sp. nov.

Coloniae amphigenae et caulicolae, compactae, saepe velutinae. Hyphae rectae vel undulatae, cellulis plerumque 20–27× 3–8µm, ramificantibus alternis, acutis, dense reticulatae. Hyphopodia alterna, recta vel flexa, effusa vel antrosa-recta, 24–40µm longa; cellulae basales cylindraceae vel cuneatae, 6–11µm longae; cellulae apicales versiformes, saepe irregulariter flexae, 2–5-lobatae vel rotundatae-angulosae, 18–30 × 10–12µm. Phialides infrequentes, mixtae hyphopodis, alternae, anguste conoideae, 16–19 × 6–7µm. Setae myceliales saepe numerosissimae, dispersae, simplices, acutatae ad maturitates, ad 600× 6–8µm. Perithecia dispersa, verrucosa, ad 280µm diam., cellulis paginis convexis-rotundatis. Ascosporae ellipsoideae, obtusae, 3-septatae, leviter constrictae, 47–57× 18–24µm.

Colonies amphigenous and caulicolous, dense, often velvety. Hyphae straight or undulate, cells mostly 20–27 × 3–8µm, branching alternate, acute, densely reticulate. Hyphopodia alternate, straight or bent, spreading or antrose-bent, 24–40µm long; basal cells cylindric to cuneate, 6–11µm long; apical cells versiform, often irregularly bent, 2–5-lobate or rounded-angulose, 18–30 × 10–

12µm. Phialides rare, mixed with hyphopodia, alternate, narrowly conoid, 16–19 × 6–7µm. Mycelial setae often very numerous, scattered, simple, acute at maturity, to 600 × 6–8µm. Perithecia scattered, verrucose, to 280µm in diam., surface cells convex-rounded. Ascospores ellipsoid, obtuse, 3-septate, slightly constricted, 47–57× 18–24µm.

Holotype: As *Meliola evansii* Doidge on *Mystroxylon eucleaeformis* sensu auct., non Ecklon & Zeyher = *Pterocelastrus tricuspidatus* (Lam.) Sonder (Celastraceae). South Africa, Natal Prov., Oudeni Forest, May 1922, leg. G.W. Davies s.n., PREM 11237!
Paratypes: As *Meliola evansii* Doidge, South Africa, Western Cape Province, Knysna, Deep Walls, on *Celastrus acuminatus* sensu auct. non L.f. [= *Pterocelastrus tricuspidatus* (Lam.) Sonder], 13 May 1923, leg. E.M. Doidge s.n., PREM 14206! 23 Feb. 1925, leg. J. Phillips & E.M. Doidge s.n., PREM 20346! Western Cape Province, Kentani, on *Gymnosporia albata* (N.E. Brown) Sim [= *Maytenus undata* (Thunb.) Blakelock], 7 Oct. 1914, leg. A. Pegler s.n., PREM 8392!
Illustration: Hansford, 1963. Fig. 789 (as *Meliola evansii*).

11. The sanctioned name *Meliola psidii* Fries is conserved over the earlier synonym *M. trichostroma* (Kunze) Toro.

Meliola psidii Fries:Fries, Linnaea 5:549. 1830 [as "*Melida*"]; Systema Mycologicum Fungorum 3(Index):114. 1832.
≡*Meliola trichostroma* (Kunze) Toro, J. Agric. Univ. Puerto Rico 36:62. 1952.
Basionym: *Sphaeria trichostroma* Kunze in Weigelt, Exsiccati. Unnumbered. 1827.

Two varietal names published under *M. trichostroma* are transferred to *M. psidii* as follows:

Meliola psidii Fries:Fries var. ***macrospora*** (Bat. & Peres) J.L. Crane & A.G. Jones, comb. nov.
Basionym: *Meliola trichostroma* (Kunze) Toro var. *macrospora* Bat. & Peres in Bat., H. Maia, J.A. Lima, R. Garnier & Peres, Univ. Recife Inst. Micol. Publ. 237:6. 1963.
Type: On *Psidium guajava* L. Brazil: Pernambuco, 13 Dec. 1901, leg. S.M. Tracy s.n. (Holotype: URM 15826).

Meliola psidii Fries:Fries var. ***olecranonis*** (F. Stevens & Tehon) J.L. Crane & A.G. Jones, comb. nov.
Basionym: *Meliola olecranonis* F. Stevens & Tehon, Mycologia 18:15, pl. 2, fig. 18. 1926.
≡*Meliola trichostroma* (Kunze) Toro var. *olecranonis* (F. Stevens & Tehon) Hansf., Beih. Sydowia 2:147. 1961.
Type: On *Guajava* sp. = *Psidium guajava* L. Guyana: Tumatumari, 8 Aug.1922, leg. F. Stevens No. 64 (Holotype: ILL 5715!).

Deighton (1968) suggested changing the name *olecranonis* of the original authors to *olecranoni*. The underlying term is of Greek origin, *olekranon*, meaning elbo tip or elbow. The genitive of *olecranon*, a third declension noun ending in -on is *olecranonis*. We could find no reason why the epithet should be considered a second declension noun with the genitive ending in -i.

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THE LICHEN GENUS GRAPHINA (GRAPHIDACEAE) IN AUSTRALIA: NEW REPORTS AND NEW SPECIES

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ABSTRACT:

An account of the lichen genus *Graphina* (Graphidaceae) in Australia is given. Of the 38 taxa recognised, nineteen are described as new and six are new reports for Australia. *Graphina abdita*, *G. aquilonia*, *G. atramontana*, *G. atrocelata*, *G. atronitens*, *G. borealis*, *G. boweniana*, *G. celata*, *G. daintriensis*, *G. elaiocarpa*, *G. incisa*, *G. lumbschii*, *G. lumbschii* var. *deficiens*, *G. montoensis*, *G. nothifagi*, *G. psoromica*, *G. radicola*, *G. rufopruinosa* and *G. salazinica* are described as new species and *Graphina acharii*, *G. contorta*, *G. gracilescens*, *G. hiascens*, *G. mendax* and *G. pallido-ochracea* are reported as new to Australia. In addition *G. fissofurcata* is reported to be saxicolous as well as corticolous. A lectotype is selcted for *G. pallido-ochracea.* A key to the species in Australia is given.

INTRODUCTION

The lichen genus *Graphina* Müll. Arg. (Graphidaceae) was created by Müller (Müller 1880) to separate species with hyaline muriform ascospores from the genus *Graphis* Ach. (with hyaline locular ascospores). The genus in Australia has received little study although the genus in other parts of the world has been examined in some detail. Accounts of the genus (and the number of species studied) are as follows: Brazil (51 species: Redinger 1933), Indonesia (17 species; Redinger 1936), Hawaii (20 species; Magnusson 1954), Mexico (21 species; Wirth & Hale 1963), Japan, 9 species; Nakanishi 1966), New Zealand (3 species; Hayward 1977), Dominica (25 species; Wirth & Hale 1978) and the United Kingdom (3 species; Orange 1992). The recent Checklist of Australian Lichens (Filson 1996) lists 18 species as occuring in Australia, the majority of which are based on Australian type material, the chemistry and taxonomy of which have been described (Archer 1999). In addition, *Graphina marcescens* (Fée) Müll. Arg. has recently been reported from Australia (Staiger & Kalb 1999). An additional 25 taxa found in Australia are reported here of which 19 are new.

This account is based on the examination of type and other specimens from B, BM, BRI, G, GLAM, GZU, H, HO, NSW, TUR, W and WELT and in particular the recent collections made by J.A. Elix, H. Streimann and D. Verdon (CANB), and Tasmanian collections made by G. Kantvilas (HO). In addition specimens from the private herbaria of J. Hafellner (Graz), H.T. Lumbsch (Essen) and K. Kalb (Regensburg) were examined.

The ascospores and cross-sections of lirellae were drawn with an Olympus drawing attachment. The lirellae were examined by reflected light using a Vickers x5 objective and the ascospores were examined by transmitted light with x40 and x100 objectives. The lirellae were drawn dry as when moistened the cross-sections become swollen and distorted, closed lirellae appear open and open lirellae may become grossly convex. The chemistry of the specimens was determined by thin-layer chromatography as previously reported (Archer 1999a) or by liquid chromatography (Feige *et al.* 1993) where indicated (hplc). The colour reactions of the ascospores and hymenia with iodine are reported as I-ve if no blue colour was produced.

NEW REPORTS

Graphina acharii (Fée) Müll. Arg.
in *Mem. Soc. Phys. et Hist. Nat. Geneve* **29**: 77 (1887)
= *Graphis acharii* Fée
in *Ess. Crypt. Ecorc.*: 39 (1824).

Type: SOUTH AMERICA. *s. loc.*; lectotype: G [*fide* Wirth & Hale 1978].

Thallus off-white, corticolous, surface smooth and dull; apothecia lirelliform, numerous, scattered, conspicuous, sulcate, sessile, straight, curved or sinuous, sometimes branched, 2-5(-7) mm long, 0.25-0.5 mm wide, covered by a thin thalline veil; proper exciple thick, completely carbonised; hymenium 150-200 µm tall, I-ve; ascospores (90-)100-145 µm long, 12-16 µm wide, (20-)24-28 x 2(-3) locular, I+ blue.

CHEMISTRY: no compounds found.

ILLUSTRATIONS: Redinger, Taf.2, Fig. 21 (1933); Wirth & Hale, p. 59, Plate 6f (1978).

SPECIMENS EXAMINED:
QUEENSLAND: Ravenshoe State Forest, Tully Falls Road, 23 km SE of Ravenshoe, *J.A. Elix 16034*, 23.vi.1984 (CANB); Big Tableland, 26 km S of Cooktown, *H. Streimann 30900*, 4.vii.1984 (CANB); Black Mountain, 25 km NW of Kuranda, *H. Streimann 31130*, 7.vii.1984 (CANB).

Graphina acharii is characterised by sulcate lirellae, the completely carbonised proper exciple, the absence of lichen compounds and the narrow, partly muriform ascospores.The vertical septation in the ascospores is thin and less conspicuous than the horizontal septation and is not in all locules; it is always present in the terminal locules, cf. Redinger, Taf. 2, Figs 21 & 23 (1933) and Figure 10, *Graphina aquilonia*. The lirellae in the Australian specimens are covered by a thin thalline veil, filling the grooves on the black lirellae and giving the appearance of thin white lines. In locations outside Australia the thalline covering may be thicker and more conspicuous. The species is tropical to subtropical in distribution and has been reported from South America (Fée *loc. cit.*), Mexico (Wirth & Hale 1963), Dominica (Wirth & Hale 1978), Cuba, Indonesia (Redinger 1936) and Brazil and Paraguay (Redinger 1933a).The only reported substrates in Australia are *Acacia* and *Schefflera*.

Graphina contorta Müll. Arg.
in *Rev. Mycol.* **9**: 81 (1887)

Type: NEW CALEDONIA. Nouméa, *T. Savès 11*, 1886; holotype: G.

Thallus off-white, thin, corticolous, surface smooth and dull; apothecia lirelliform, inconspicuous, immersed, numerous, scattered, visible as a thin black line on the thallus surface, with an indistinct thalline margin, straight, curved or sinuous, rarely branched, 1-3 mm long, 0.1-0.25 mm wide; proper exciple indistinct, pale yellowish brown, apically carbonised; hymenium 125-150 µm tall, I-; ascospores 1 per ascus, ellipsoid, hyaline, 57-80 µm long, 16-26 µm wide, 12-16 x 2-4 locular, I+ blue-violet.

CHEMISTRY: no compounds found.

ILLUSTRATIONS: Redinger Taf. IV, Fig. 37 (1933); Hayward, Fig. 3A, p. 568, Fig. 5A, p. 570 (1977) [as *Graphina monospora*].

SPECIMENS EXAMINED:
QUEENSLAND: Leichardt Highway, 8 km NNW of Taroom, *J.A. Elix 35084*, 30.viii.1993 (CANB); Capricorn Highway, 19 km ESE of Duaringa, *J.A. Elix 34426*, 22.viii.1993 (B, CANB); Carnarvon Highway, 68 km N of Injune, *J.A. Elix 34048*, 19.viii.1993 (B, CANB).

Graphina contorta is characterised by the inconspicuous immersed lirellae, the apically carbonised proper exciple and the absence of lichen compounds. It resembles *Graphis malacodes* Nyl. [syn: *Graphis argopholis* Müll. Arg.] but is distinguished from that species by the muriform ascospores. The description of the Australian specimens cited above agrees with that of Müller *(loc. cit.)* who reported the ascospores in his New Caledonian species to be 75-90 µm long, 23-26 µm wide and 12 x 2-4 -locular

Similar specimens from New Zealand were described and illustrated by Hayward (1977) who reported the ascospores to be muriform, 75-95 µm long and 35-60 µm wide but identified the specimens as *G. monospora* (Knight) Müll. Arg. However, the ascospores in *G. monospora* are much larger than those in *G. contorta*.. Knight (1883) reported the ascospores in *G. monospora* to be 180 x 80 µm, and Nylander (1888) reported the ascospore size as 185-200 x 65-135 µm. *Graphina contorta* is here retained as a separate species although Hayward (1977) suggested that *G. contorta* might be a later name for *G. monospora*. *Graphina contorta* is also reported from Paraguay (Redinger 1933a). In Australia the only reported substrate is *Acacia*.

Graphina fissofurcata (Leight.) Müll. Arg.
in *Flora* **65**: 385 (1882).
= *Graphis fissofurcata* Leighton
in *Trans. Linn. Soc. London, Bot.* **27:** 177 (1869)

Type: CEYLON [SRI LANKA] Nuwara Eliya, 6000 ft., *G.H.K. Thwaites C.L. 75*; lectotype: BM.

= *Graphis hiascens* (Fée) Müll. Arg. var. *clausior* Vain.
in *Ann. Acad. Sci. Fenn.*, ser. A, 15, **6**: 204 (1920)

Type: PHILIPPINES. Luzon, Rizal, Antipolo, *M. Ramos & G. Edaño*, July 1917, Bureau of Science no. 29548; holotype: TUR-V 27227.

= *Grahina tjibodensis* Zahlbr.
in *Ann. Cryptog. Exot.* **1:** 137 (1928)

Type: JAVA [INDONESIA].Tjibodas, 1500 m, *C. van Overeem 100*; holotype: W.

Thallus off-white to pale fawn to pale olive green, corticolous or saxicolous, surface smooth to sub-tuberculate and dull; apothecia lirelliform, black, conspicuous, numerous, sometimes crowded, straight, curved or sinuous, often branched, initially slit-like, becoming sessile, lips usually closed, sometimes becoming slightly open, 1-5(-8) mm long, 0.3-0.7 mm wide, with a well-developed thalline margin; proper exciple laterally carbonised; hymenium (125-)150-175 µm tall, I-ve; ascospores (60-)70-90(-100) µm long, 15-24(-28) µm wide, (12-)13-16 x 2-4-locular, I+ blue.

CHEMISTRY: stictic acid.

ILLUSTRATION: Redinger Plate IV, fig. 54 (Redinger 1936) [as *G. tjibodensis*].

SELECTED SPECIMENS EXAMINED:
Corticolous (6 of 21):
QUEENSLAND: Yuccabine Creek, Cardwell Range, 27 km WNW of Cardwell, *J.A. Elix 15739*, 20.vi.1984 (CANB); Mount Baldy, 4 km SW of Atherton, *J.A. Elix 16289*, 25.vi.1984 (CANB); Wooroonooran National Park, Babinda Boulders, *H.T. Lumbsch 11151w*, 29.vii.1996 (herb. Lumbsch); Mount Tambourine, *J. Shirley s.n.*, May 1888 (NSW 426683); Main Coast Range, 19 km NNW of Mount Molloy, *H. Streimann 30260*, 30.vi.1984 (CANB); Track to Mount Misery, 47 km S of Cooktown, *H. Streimann 57496*, 22.x.1995 (CANB).

Saxicolous:
QUEENSLAND: Windsor Tableland, 38 km NW of Mossman, *J.A. Elix 16539*, 26.vi.1984 (CANB); Bellenden Ker Range, Bartle Frere, Mulgrave River, *H.T. Lumbsch 5401g*, 13.viii.1987 (herb. Lumbsch); Home Rule falls, Wallaby Creek, 30 km SSE of Cooktown, *H. Streimann 57550*, 23.x.1995 (B, CANB); Mount Spec State Forest, Paluma Range, 6 km W of Paluma, *H. Streimann 37030*, 18.vi.1986 (CANB).
NEW SOUTH WALES: Conglomerate State Forest, Waihou Road, near Waihou, *ca.* 25 km NNW of Coffs Harbour, *D. Verdon 3816*, 12.x.1976 (CANB); *ibid.*, *A.W. Archer G 188*, 19.iv.1998 (NSW).

Graphina fissofurcata is characterised by the large lirellae with conspicuous thalline margins, the laterally carbonised proper exciple, the large ascospores and the presence of stictic acid. The species is both corticolous and saxicolous in Australia (common in Queensland and New South Wales) and also occurs in India, Sri Lanka, the Philippines, Fiji and Indonesia.
Graphina fissofurcata was first reported from Australia by J. Shirley (Shirley 1889).
Reported substrates for corticolous specimens include *Araucaria*, *Cryptocarya*, *Endiandra* and *Ficus*.
The presence of stictic acid distinguishes saxicolous specimens of *G. fissofurcata* from the somewhat similar *G. saxicola* Müll. Arg. which contains norstictic acid.

Graphina gracilescens (Vain.) Zahlbr.
in Cat. Lich. Univ. **2**: 407 (1922).
= *Graphis gracilescens* Vain.
in *Ann. Acad. Sci. Fenn.* ser.A, 15, **6**: 203 (1920).

Type: MARIANAS ISLANDS, Guam, *R.C. McGregor 604*, Oct. 1911; holotype: TUR-V 27238

Thallus off-white, thin, corticolous, surface smooth and dull; apothecia lirelliform, black, numerous, crowded, sub-sessile to sessile, conspicuous, straight, curved or sinuous, rarely branched, lips closed, sometimes becoming slighltly sulcate, negligible thalline margin, 1-4 mm long, 0.1-0.25 mm wide; proper exciple laterally carbonised; hymenium 125-150 µm tall, I-; ascospores 8 per ascus, ellipsoid, hyaline, (20-)25-35 µm long, (11-)13-15 µm wide, 4-6 x 2-3(-4)-locular, I+ blue-violet.

CHEMISTRY: norstictic acid.

SPECIMENS EXAMINED:
AUSTRALIA. QUEENSLAND: Clarke Range, 46 km SSW of Proserpine, *J.A. Elix 20853*, 29.vi.1986 (CANB); Mount French, 6 km SW of Boonah, *D. Verdon 5192*, 22.i.1983 (CANB).

Graphina gracilescens is characterised by the numerous, semi-immersed lirellae, the laterally carbonised proper exciple and the presence of norstictic acid. The species resembles *Graphina pertricosa* (Kremp.) Redinger (Redinger 1936) in ascospore dimensions, the laterally carbonised exciple and the presence of norstictic acid but differs in the sulcate, sessile lirellae and ascospores with fewer locules. The lirellae in *G. pertricosa* are smooth and immersed, and the ascospores are 8-9 x 3-5 locular. In Australia *Graphina gracilescens* is known from the two collections cited above with *Argyrodendron* as substrate.

Graphina hiascens (Fée) Müll. Arg.
in *Mem. Soc. Phys. Nat. Hist. Geneve* **29**: 42 (1887).
= *Opegrapha hiascens* Fée
in *Suppl. Ess. Crypt. Ecorc.*: 25 (1837).
[Wirth & Hale (1963: 78) list additional synonyms.]

Type: SOUTH AMERICA. *s. loc.* holotype: G; (*fide* Wirth & Hale 1963).

Thallus pale fawn, thin, corticolous, surface smooth and dull. Lirellae conspicuous, numerous, scattered, simple, short and wide, sessile, unbranched, lips closed, 0.5-2 mm long, 0.3-0.5 mm wide, with a conspicuous thick thalline margin. Proper exciple thick, laterally carbonised; hymenium 125-175 µm tall, I-ve; ascospores 90-110 µm long, 15-20 µm wide, 24 x 3-6-locular, I+ blue.

CHEMISTRY: norstictic acid.

ILLUSTRATION:Wirth & Hale, Figs. 17-20, p. 79 (1963).

SPECIMEN EXAMINED:
QUEENSLAND: O'Keefe Creek, Big Tableland, 26 km S of Cooktown, on *Acacia*, *H. Streimann 30919 p.p.*, 4.vii.1984 (CANB).

Graphina hiascens is characterised by the conspicuous, short, wide lirellae, the laterally carbonised proper exciple, the presence of norstictic acid and the long narrow muriform ascospores. Unlike the ascospores in *Graphina acharii*, the vertical septation is conspicuous and in all locules. The species has a tropical to subtropical distribution and has been reported from South America (Müller 1887a), Mexico, (Wirth & Hale 1963), and Indonesia [as *G. subserpentina* (Nyl.) Müll. Arg.] (Redinger 1933b). The species is distinguished from the chemically similar *G. palmicola* Müll. Arg. (Müller 1887b) by the short simple conspicuously sessile lirellae in contrast to the longer, sometimes branched, sub-immersed lirellae of *G. palmicola. Graphina hiascens* resembles the two new taxa *G. lumbschii* and *G. lumbschii* var. *deficiens*, *vide infra*; the differences between these three taxa are summarised in Table 1.

Graphina mendax (Nyl.) Müll. Arg.
in *Rev. Mycol.* **10**: 177 (1888).
= *Graphis mendax* Nyl.
in in *Ann. Sci. Nat. Bot.* sér. 4, **11**: 244 (1859).

Type: TAHITI. Papeete, *D.Jardin s.n.*; lectotype: H-NYL-7929 (*fide* Nakanishi 1973, *in sched.*); residual syntype: H-NYL 6826.

= *Graphina diorygmatoides* (Vain.) Zahlbr.

in *Cat. Lich. Univ*. **2**: 249 (1922).
= *Graphis diorygmatoides* Vain.
in *Ann. Acad. Sci. Fenn*., ser. A, 15, **6**: 218 (1921)

Type: PHILIPPINES. Luzon, Manilla, *E.D. Merrill 8515*, Jan 1913; holotype TUR-V 27271

= *Graphina peralbata* (Vain.) Zahlbr.
in *Cat. Lich. Univ*. **2**: 249 (1922).
= *Graphis peralbata* Vain.
in *Ann. Acad. Sci. Fenn*., ser. A, 15, **6**: 219 (1921)

Type: PHILIPPINES. Negros, Bago, Hacienda Louisiana, *E.D. Merrill 6800*, Apr 1910; holotype: TUR-V 27273.

= *Graphina fecunda* Zahlbr.
in *Ann. Cryptog. exot*. **1**: 140 (1928).

Type: JAVA [INDONESIA].Bogor, "in horto Botanico Bogoriensis", *C. van Overeem 342 p.p.*; holotype: W.

Thallus pale greyish white, thick, corticolous, surface smooth and dull; apothecia lirelliform, inconspicuous, numerous, sometimes crowded, initially immersed, becoming sub-immersed to sessile, with a conspicuous, raised thalline margin, lips initially closed, opening to reveal white pruinose epithecium, straight, curved or sinuous, rarely branched, 1-4 mm long, 0.2-0.5 mm wide; proper exciple absent; hymenium 125-175 µm tall, I+ pale blue; ascospores 1 per ascus, ellipsoid, hyaline, (70-)78-105 µm long, 20-35 µm wide, densely muriform, *ca*. 30 x 6 locular, I+ blue.

CHEMISTRY: norstictic acid.

ILLUSTRATIONS: Redinger, Taf. V, Fig. 54 (1933); Redinger, Taf. V, Fig. 62 (1936) [as *Graphina fecunda*].

SPECIMENS EXAMINED:
NORTHERN TERRITORY: Black Jungle, 41 km ESE of Darwin, *H.T. Lumbsch 8870*, July 1991 (herb. Lumbsch).
QUEENSLAND: 3 km S of Forrest Beach, 16 km S of Ingham, *J.A. Elix 15922*, 22.vi.1984 (CANB); Mount Fox, 43 km SW of Ingham, *J.A. Elix 20356*, 19.vi.1986 (CANB); 1 km N of Cardwell, *H.T. Lumbsch 11097m*, July 1996 (herb. Lumbsch); Cooktown, trail from Grassy Hill to Cherry Tree Bay, *H.T. Lumbsch 11173t,* Aug 1996 (herb. Lumbsch); Cockatoo Creek, at junction with Alligator Creek, Bowling Green Bay National Park, 27 km SE of Townsville, *H. Streimann 56263*, Oct 1995 (CANB); Four Mile Beach, 1 km S of Port Douglas, *D. Verdon 5446*, 6.ii.1983 (CANB); Finch Bay, 2 km E of Cooktown, *D. Verdon 5435*, 4.ii.1983 (CANB);
NEW CALEDONIA. *s. loc*., *Vieillard, s.n*., (H-NYL 6943).
VANUATU. Malokola [Malekula], *F.W. Leggatt s.n.,* no date [*ca*. 1890], (NSW 438465 pp).

Graphina mendax is characterised by the off-white thallus, the inconspicuous open lirellae, the white pruinose epithecium, the large muriform ascospores and the presence of norstictic acid. The hymenium is stained blue with iodine, an uncommon feature in the genus *Graphina* and noted by Redinger (1933) ("sehr auffallend") but one shared with the type specimens of the synonymous taxa cited above and also *Graphina suberythrella* Hale and *G. pachygrapha* (Nyl.) Zahlbr. In his key to Vainio's Philippine Graphidaceae, Redinger reported *G. peralbata* (Vain.) Zahlbr. to be a synonym of *G.*

mendax (Redinger 1936a). In the type specimen of *G. fecunda* from Indonesia, the lirellae are slightly rounded and crowded but are otherwise identical to the Australian specimens cited above. When the white pruina is removed from the epithecia, e.g. by abrasion, the exposed epithecium is black. Such exposed epithecia are present in the lectotype of *G. mendax* but in the residual syntype the epithecia are white pruinose and resemble the Australian specimens examined.

The species occurs in the Philippines, India, Tahiti, Indonesia, New Caledonia, Vanuatu and, in Australia, in the Northern Territory and Queensland. The species was reported from Brazil and Paraguay (Redinger 1933a) and also from the USA (Fink 1935) but the latter report is based on a misidentification (Esslinger & Egan 1995). In Australia the only reported substrates are mangroves.

Graphina pallido-ochracea (Kremp.) Zahlbr.
in *Cat. Lich. Univ.* **2**: 417 (1924).
= *Graphis pallido-ochracea* Kremp.
in *Nuovo. Giorn. Bot. Ital.* **7**: 32 (1875).

Type: SARAWAK. *s. loc.*, *O. Beccari 105*, 1866; lectotype, here selected: M; residual syntype: *O. Beccari 79* (M).

= *Graphina albidolivens* (Vain.) Zahlbr.
in Cat. Lich. Univ.
= *Graphis albibolivens* Vain.
in *Ann. Acad. Sci. Fenn.*, ser. A, 15, **6**: 217 (1920).

Type: PHILIPPINES. Luzon, Sorsogon, Irosin, *A.D.E. Elmer 15029*; lectotype: TUR-V 27306

= *Graphina philippina* (Vain.) Zahlbr.
in Cat. Lich. Univ.
= *Graphis philippina* Vain.
in *Ann. Acad. Sci. Fenn.*, ser. A, 15, **6**: 216 (1920).

Type: PHILIPPINES. Luzon, Sorsogon, Irosin, *A.D.E. Elmer 15042*; syntypes: TUR-V 27264, 27265.

Thallus white to off-white to pale greenish white, thin, corticolous, surface smooth and dull; apothecia lirelliform, white, numerous, conspicuous, sub-sessile to immersed, with a well-defined, raised thalline margin, lips open, straight, curved or sinuous, rarely branched, 1-4 mm long, (0.2-)0.4-0.5 mm wide; proper exciple pale brown, ill-defined, lateral; hymenium 125-150 µm tall, I-ve; epithecium initially smooth and epruinose, becoming off-white to pale brown pruinose; ascospores 1 per ascus, narrow ellipsoid, hyaline, 80-120(-145) µm long, 20-35(-45) µm wide, muriform, I+ blue.

CHEMISTRY: stictic acid.

ILLUSTRATION: Redinger, Tab. V, Fig. 60 (1936).

SPECIMENS EXAMINED:
QUEENSLAND: Wooroonooran National Park, Palmerston Section, Henrietta Creek camping area, *H.T. Lumbsch 11113a*, 17.vii.1996 (herb. Lumbsch); Russell River National Park, 8 km NE of Babinda, *H.T. Lumbsch 11138o*, 24.vii.1996 (herb. Lumbsch).
NEW SOUTH WALES: Broken Head, ca. 8 km S of Byron Bay, *A.W. Archer G 291*, 5.xi.1998 (NSW); Brunswick Heads, S side of Brunswick River, *A.W. Archer 284*, 5.xi.1998 (NSW).

NORFOLK ISLAND. Mount Pitt Reserve, Filmy Fern Trail, *J.A. Elix 18430*, 3.xii.1984 (CANB).
VANUATU. Malokola [Malekula], *F.W.Leggatt s.n.*, Mar. 1890 (NSW 438458 pp); *s. loc., F.R.M. Wilson s.n.,* 1895 (NSW).

Graphina pallido-ochracea is characterised by the conspicuous white, open lirella with pruinose discs, the absence of a carbonised proper exciple and the presence of stictic acid. The species resembles *Cyclographina platyleuca* (Nyl.) Awasthi & Joshi which also has a pale greenish-white thallus and white immersed lirellae but *C. platyleuca* contains protocetraric acid.
The species occurs in Sarawak, the Philippines and Vanuatu, and in Australia in rain forest in Queensland and New South Wales, and also on Norfolk Island.
There are two syntypes of *G. pallido-ochraceae* in the Krempelhuber collection in M; of these, the larger of the two specimens, Beccari 105, is chosen as lectotype.

NEW SPECIES

Graphina abdita A.W. Archer Figures 1 & 19

Sicut *Graphina gyridia* (Stirt.) Zahlbr. sed ascosporis majoribus et lirellis immersis.

Type: AUSTRALIA. Queensland: Souita Falls, ca. 10 km W of Milla Milla, 17°34'S, 145°38'E, on fallen tree, *H.T. Lumbsch 11128k*, 21.vii.1996; holotype: CANB.

Thallus off-white, thin, corticolous, surface smooth and dull; lirellae, inconspicuous, fissurine, immersed, scattered, with slightly raised margins, straight or bifurcated, 0.5-1.5 mm long, 0.2 mm wide; proper exciple thin, ill-defined, complete, pale reddish-brown; hymenium 90-100 μm tall, I-ve; ascospores 8 per ascus, narrow ellipsoid, hyaline, 28-35 μm long, 8-10 μm wide, 8-10 x 2-3 locular, I+ blue.

CHEMISTRY: stictic acid

Graphina abdita is charcterised by the inconspicuous fissurine lirellae, the pale reddish brown exciple and the presence of stictic acid. It is distinguished from the chemically similar *G. gyridia* (Stirt.) Zahlbr. by the larger ascospores (18-25 x 6-8 μm in *G. gyridia*) and the immersed lirellae, sessile in *G. gyridia;* this latter species is so far known only from Victoria and Tasmania. *Graphina abdita* is known only from the type specimen.
The epithet *abdita*, is from the Latin *abditus*, hidden, concealed, a reference to the inconspicuous, immersed lirellae.

Graphina aquilonia A.W. Archer Figures 2 & 20

Sicut *Graphina acharii* (Fée) Müll. Arg. sed acidum norsticticum continens et ascosporis minoribus.

Type: AUSTRALIA. Queensland: Track to old Leo Creek mine, McIlwraith Range, 28 km NE of Coen, 13°44'S, 143°19'E, alt. 430 m, on fallen tree branch, *H. Streimann 56768*, 17.x.1995; holotype: CANB.

Thallus pale greyish-white, thick, corticolous, surface smooth and dull; apothecia lirelliform, white, becoming black where abraded, conspicuous, numerous, straight, curved or sinuous, sometimes branched, sessile, with a conspicuous thalline margin, (1-)2-7 mm long, 0.25-0.5 mm wide; proper exciple thick, completely carbonised; hymenium 200-225 μm tall, I-ve; ascospores (72-)85-105 μm long, (11-)13-16 μm wide, 16-20(-22) x 2-3 locular, muriform in the terminal locules only, I+ blue.

CHEMISTRY: norstictic acid.

SPECIMENS EXAMINED:
Queensland: Black Mountain, 25 km NW of Kuranda, alt. 500 m, *J.A. Elix 17504*, 7.vii.1984 (CANB); Ingham-Kangaroo Hills Road, 30 km WSW of Ingham, alt. 200 m, *H. Streimann 37164*, 19.vii.1986 (CANB).

Graphina aquilonia is characterised by the conspicuous lirellae, the completely carbonised proper exciple, large ascospores and the presence of norstictic acid. The species resembles *G. acharii*, which also occurs in Australia, but is distinguished from that species by the presence of norstictic acid and slightly smaller ascospores; *Graphina acharii* lacks lichen compounds. Both *G. aquilonia* and *G. acharii* possess ascospores in which only the terminal and subterminal locules are muriform. Externally, the new species resembles the Brazilan species *G. carassensis* (Vainio) Zahlbr. [holotype: TUR-V 21771] but that sepcies is saxicolous and lacks lichen compounds. The only reported substrate in Australia is *Acacia*.
The epithet *aquilonia*, northern, refers to the occurrence of the species in northern Queensland.

Graphina atramontana A.W. Archer Figures 3 & 21

Sicut *Graphina rubens* Müll. Arg. sed ascosporis majoribus.

Type: AUSTRALIA. Queensland: Black Mountain, 25 km N of Kuranda, 16°40'S, 145°29'E,alt. 500 m, in "dry" rain forest, on *Acacia*, *H. Streimann 31102*, 7.vii.1984; holotype: CANB.

Thallus very pale greyish-green, thick, corticolous, surface smooth and shiny; apothecia lirelliform, numerous, conspicuous, sessile, straight, curved or sinuous, sometimes branched, lips becoming open, revealing dark reddish brown, faintly white pruinose epithecium, with a conspicuous, wide thalline margin, 1-5 mm long, 0.4-0.7 mm wide; proper exciple indistinct, red brown at base; hymenium 150-175 µm tall, I-; ascospores 8 per ascus, ellipsoid, hyaline, 36-52 µm long, 11-18 µm wide, 7-9 x 3-4 locular, I+ blue-violet.

CHEMISTRY: norstictic acid.

The species is characterised by the conspicuous lirellae, opening to reveal a pruinose red-brown epithecium, the absence of a proper exciple and the presence of norstictic acid. The new species resembles *Graphina rubens* Müll. Arg. (Müller 1882) but that species has imersed lirellae and smaller ascospores. The chemistry of *G. rubens* has not been reported but Redinger (1936) reported the thallus to react K+ red, suggesting the presence of norstictic acid. The species is so far known only from the type specimen.
The epithet, *atramontana*, is derived from *atra*, Latin, black, and *montana*, Latin, mountain, a reference to the type locality.

Graphina atrocelata A.W. Archer Figures 4 & 22

Sicut *Phaeographina pudica* (Mont. & v.d. Bosch) Zahlbr. sed ascosporis hyalinis.

Type: AUSTRALIA. Queensland: D'Aguilar Range, NW of Mount Glorious, alt. 680 m, 27°21'S, 152°46'E, on edge of rainforest, *J. Hafellner 16977*, 1.viii.1986; holotype: CANB; isotype: GZU.

Thallus olive green, corticolous, surface sub-tuberculate, smooth and dull; apothecia lirelliform, conspicuous, scattered, sessile, concolorous with the thallus, lips pale fawn, closed, straight, curved or sinuous, unbranched, 1-4(-6) mm long, 0.3-0.4 mm wide, with a conspicuous thalline margin; proper exciple laterally carbonised, concealed in the thalline margin, visible only in abraded lirellae; hymenium *ca.* 125-175 µm tall, I-ve; ascospores 120-140 µm long, 35-40 µm wide, densely muriform, I+ blue.

CHEMISTRY: no compounds found.

Graphina atrocelata is characterised by the concealed laterally carbonised proper exciple, the muriform ascospores and the absence of lichen compounds. The new taxon resembles *Phaeographina pudica* (Mont. & v.d. Bosch) Zahlbr. externally but is distinguished from that species by the hyaline ascospores. The species is so far known only from the type specimen.
The epithet *atrocelata* is from the Latin *atra*, black and *celata*, hidden, a reference to the cconcealed black proper exciple.

Graphina atronitens A.W. Archer Figures 5 & 23

Sicut *Graphina incrustans* (Fée) Müll. Arg. sed ascosporis majoribus et iodo coerulescens, et epithiciis nitidis

Type: AUSTRALIA. NEW SOUTH WALES: Black Rock, track behind beach, *ca.* 7 km S of Brunswick Heads, 28°36'30"S, 153°34'30"E, alt. *ca.* 5 m, *A.W. Archer G 292*, 5.xi.1998; holotype: NSW.

Thallus off-white to pale greyish white, thin, corticolous, surface smooth and dull; apothecia lirelliform, inconspicuous, numerous, scattered, initially fissurine, becoming open, immersed to sub-sessile, with a thin thalline margin. straight or curved, sometimes branched, 0.5-1(-1.5) mm long, 0.1-0.2 mm wide; epithecium black, epruinose, shiny; proper exciple inconspicuoius, uncarbonised; hymenium 100-125 µm tall, I-ve; ascospores 8 per ascus, ellipsoid, hyaline, muriform, 30-45 µm long, 10-15 µm wide, 7-10 x 2-4 locular, I+ blue.

CHEMISTRY: no compounds found.

SPECIMENS EXAMINED:
NEW SOUTH WALES: type locality, *A.W. Archer G 311,* 5.xi.1998 (NSW); South Ballina, on tree by side of Richmond River, *A.W. Archer G 299*, 2.xi.1998 (NSW).
VICTORIA: Lake Tyers, *F.Wilson s.n.*, Mar 1888 (NSW 426609); Lakes Entrance, *F. Wilson s.n.*, Mar 1889 (NSW 426614); Maffra, Macalister River, *F. Wilson s.n.,* Sept 1886 (NSW 426610).
NORFOLK ISLAND. Rocky Point Reserve, *J.A. Elix 18237*, 2.xii.1984 (CANB); *ibid., H. Streimann 31808*, 2.xii.1984 (CANB).

Graphina atronitens is characterised by the small, inconspicuous, open lirellae, the black, shiny epithecium and the absence of lichen compounds. As in *G. incrustans*, the lirellae are initially fissurine but although remaining immersed, open to reveal a conspicuous black, shiny epithecium. The ascospores in *G. atronitens* differ from those of *G. incrustans* in that they are larger, 34-45 x 10-15 µm, as opposed to to 13-35 x 6-11 µm in *G. incrustans* (*fide* Wirth & Hale 1978). The species occurs in New South Wales, Victoria and Norfolk Island. Reported substrates include *Hymenanthea*, *Melia*, *Notalea* and *Pittosporum.*
The epithet *atronitens* is from the latin *atro*, black and *nitens*, shining, a reference to the black, shiny epithecium.

Graphina borealis A.W. Archer Figures 6 & 24

Sicut *Graphina pertricosa* (Kremp.) Redinger sed ascosporis majoribus et lirellis immersis.

Type: AUSTRALIA. QUEENSLAND: Gordon Creek, 19 km SW of Cape Weymouth, (9 km NW of Lockhart River Settlement), 12°43'S, 143°18'E, alt. 120 m, on semi-shaded tree trunk in monsoon forest, *H. Streimann 56574*, 13.x.1995; holotype: CANB; isotypes: B, H.

Thallus pale fawn, thin, corticolous, surface smooth and dull; apothecia lirelliform, black, immersed, conspicuous, scattered, with a slightly raised thalline margin, straight, curved or sinuous, often branched, lips closed, 0.5-2(-3) mm long, 0.1-0.15 mm wide; proper exciple laterally carbonised; hymenium 80-150 µm tall. I-ve; ascospores ellipsoid, hyaline, 37-51 µm long, 17-25 µm wide, 6-8 x 2-4 locular, I+ blue.

CHEMISTRY: norstictic acid

SPECIMEN EXAMINED: FIJI, s. loc., *F.R.M. Wilson s.n.* (NSW L 4999).

Graphina borealis is characterised by the conspicuous lirellae with the proper exciple laterally carbonised and the presence of norstictic acid. The species resmbles *Graphina pertricosa* (Kremp.) Redinger but is distinguished from that species by the narrower, immersed lirellae and the larger ellipsoid ascospores in *G. borealis*. The species is so far known only from the two specimens cited above, from Queensland and Fiji.
The epithet *borealis*, northern, refers to the occurrence of the species in northern Queensland.

Graphina boweniana A.W. Archer Figures 7 & 25

Sicut *Graphina pallido-ochracea* (Kremp.) Zahlbr. sed acidum norsticticum continens et pruina alba.

Type: AUSTRALIA. QUEENSLAND: Stony Creek, Bowenia State Forest, 25 km NNW of Yeppoon, 22°55'S, 150°39'E, alt. 100m, in remnant rainforest in head of gully, on *Casuarina, J.A. Elix 34564*, 24.viii.1993; holotype: CANB.

Thallus off-white, thin, corticolous, surface sub-tartareous and dull; apothecia conspicuous, numerous, sessile, white, scattered or clustered, open, rounded to oval, straight, curved or sinuous, rarely branched, with a conspicuous thalline margin, 1-3 mm long, 0.4-1.0 mm wide; proper exciple absent; hymenium I-, 160-210 µm tall; epithecium dark reddish brown, white pruinose; ascospores ellipsoid, hyaline, (115-)137-175 µm long, (30-)45-55 µm wide, densely muriform, I+ blue-violet.

CHEMISTRY: norstictic acid.

SPECIMENS EXAMINED:
QUEENSLAND: Cook District, McIlwraith Range, Chester River Gorge, *G. Butler 462*, 29.vii.1978 (CANB); Daintree National Park, 5 km N of Cape Tribulation, *H.T. Lumbsch 11161j*, 3.viii.1996 (herb. Lumbsch).

Graphina boweniana is characterised by the conspicuous, white, rounded, open lirellae, the large muriform ascospores and the presence of norstictic acid. The open lirellae resemble those of *G. pallido-ochracea* (Krempel.) Zahlbr. but the new species is differentiated from that species by the white pruinose epithecia and the presence of norstictic acid; *G. pallido-ochracea* contains stictic acid. It resembles the new species *G. rufopruinosa* (vide infra) but is distinguished from that species by the shape of the lirellae, the white pruinose epithecia and the absence of protocetraric acid.
The species occurs in north-eastern Queensland in rainforest and wet sclerophyll forest. The only reported substrate is *Casuarina.*
The epithet *boweniana* refers to the type locality, the Bowenia State Forest.

Graphina celata A.W. Archer Figures 8 & 27

Sicut *Graphina novae-zelandiae* (C. Knight) G. Hayward. sed excipulo dimidatao et ascosporis majoribus.

Type: AUSTRALIA. Queensland: McIlwraith Range, 27 km NE of Coen, 13°43'S, 143°19'E, alt. 400 m, *H. Streimann 56807*, 17.x.1995; holotype: CANB.

Thallus dull fawn, 0.1-0.2 mm thick, saxicolous, surface smooth and dull; apothecia lirelliform, inconspicuous, thin, black, immersed, curved and sinuous, often branched, 1-4 mm long, 0.1-0.15 mm wide, lips closed, sometimes becoming slightly open; proper exciple apically to laterally carbonised; hymenium 100-150 μm tall, I-ve; ascospores 69-90 μm long, 20-26 μm wide, muriform, *ca.* 14-16 x 2-4 locular, I+blue.

CHEMISTRY: no compounds found.

SPECIMEN EXAMINED:
QUEENSLAND: Lllankelly Creek, McIlwraith Range, on shaded boulder, 9 km NE of Coen, *H. Streimann 56848*, 18.x.1995 (B, CANB).

Graphina celata is characterised by the inconspicuous, immersed lirellae, the hyaline muriform ascospores and the absence of lichen compounds.
The new species resembles *Graphina novae-zelandiae* (C.Knight) G.Hayward but is distinguished from that species by the laterally carbonised proper exciple and the larger ascospores (19-24 x 7-10 μm in *G. novae-zelandiae*); neither species contain lichen compounds. The new species is so far known only from the McIlwraith Range in northern Queensland.
The epithet *celata*, from the Latin *celatus*, hidden, refers to the inconspicuous, immersed lirellae.

Graphina daintriensis A.W. Archer Figures 9 & 27

Sicut *Graphina hiascens* (Fée) Müll. Arg. sed acidis lichenicis deficiens et ascosporis minoribus.

Type: AUSTRALIA Queensland: Rex Creek, Mossman Gorge, Daintree River National Park, 6 km W of Mossman, *H. Streimann 45823*, 5.xii.1990 holotype: CANB.

Thallus off-white, thin, corticolous, surface smooth and dull; apothecia lirelliform, conspicuous, black, sub-immersed to sub-sessile, straight, curved or sinuous, rarely branched, 1-3 mm long, 0.2-0.3 mm wide, lips closed or becoming slightly open, with thin, variable thalline margin; proper exciple laterally or sometimes almost completely carbonised; hymenium 120-150(-200) μm tall, I-ve;. ascospores 1 per ascus, (55-)60-

86(-92) µm long, (16-)20-32 µm wide, densely muriform, *ca.* 16 x 6 locular, I+ blue.

CHEMISTRY: no compounds found.

SPECIMENS EXAMINED:
QUEENSLAND: Bartle Frere, Bellenden Ker Range, Mulgrave River, *H.T. Lumbsch 5406d*, 13.viii.1987 (herb. Lumbsch); Davies Creek National Park, Davies Creek Falls, *H.T. Lumbsch 11148d*, 27.vii.1996 (herb. Lumbsch); McIlwraith Range, track to old Leo Creek mine, 28 km NE of Coen, *H. Streimann 56787* (CANB); Cape Tribulation National Park, 38 km NNE of Mossman, *H. Streimann 45783*, 4.xii.1990 (CANB); Crediton State Forest, 20 km SSW of Finch Hatton, *H. Streimann 37667*, 1.vii.1986 (CANB); Helenvale-Roseville Road, 29km S of Cooktown, *H. Streimann 31013*, 5.vii.1984 (CANB).

Graphina daintriensis is characterised by the immersed lirellae, the laterally carbonised proper exciple and the absence of lichen compounds. It resembles *G. hiascens* (*vide supra*) but is distinguished from that species by the smaller ascospores and the absence of lichen compounds; *G. hiascens* contains norstictic acid. *G. daintriensis* also resembles the new species *G. lumbschii* var. *deficiens* (*vide infra*) but is differentiated from that species by the completely carbonised proper exciple and the longer, narrower ascospores in that species. Reported substrates include *Argyrodendron*, *Herietiera* and *Melaleuca.*
The epithet *daintriensis* refers to the type locality, Daintree River National Park.

Graphina elaiocarpa A.W. Archer Figures 10 & 28

Sicut *Graphina incrustans* (Fée) Müll. Arg. sed lirellis semper sessilis et ascosporis latioris.

Type: AUSTRALIA. NEW SOUTH WALES: Dahrug National Park, by side of Mill Creek, *ca.* 60 km NNW of Sydney, *A.W. Archer G 150*, 19.ii.1998 (NSW).

Thallus olive green, corticolous, surface slightly sub-tuberculate and shiny; apothecia lirelliform, lirellae conspicuous, sessile, concolorous with the thallus, straight, curved or sinuous, unbranched, 1-6(-8) mm long, 0.5-0.8 mm wide, to 0.4 mm high, lips sometimes opening slightly to reveal the proper exciple; proper exciple complete, red brown; hymenium 150-200 µm tall; ascospores 8 per ascus, 21-28 µm long, 13-18 µm wide, 4-5 x (2-)3-4 locular, I+ blue.

CHEMISTRY: no compounds found.

SPECIMENS EXAMINED:
NEW SOUTH WALES: Allyn Rover Forest Park, Burraga Swamp, *G. Kantvilas 226/88*, 29.vi.1988 (HO, NSW).
QUEENSLAND: Goomburra State Forest, Mount Castle Lookout, *ca.* 50 km NW of Warwick, *H.T. Lumbsch 5689e*, 28.ix.1987 (herb. Lumbsch).

Graphina elaiocarpa is characterised by the large, conspicuous, sessile lirellae, the reddish brown proper exciple and the absence of lichen compounds. The ascospores and the structure of the lirellae resemble those present in *G. incrustans* [*cf.* Wirth & Hale fig. 9h, p. 35 and Plate 8f, p. 61 (1978)] but the lirellae in *G. elaiocarpa* are always sessile and are not initially fissurine as in *G. incrustans* and the ascospores are wider, 13-18 µm, compared to 6-11 µm in *G. incrustans* (Wirth & Hale 1978).
The new species occurs in Queensland and New South wales; the only reported substrate is *Nothofagus.*

The epithet *elaiocarpa* is from the Greek *elaio*, olive,and *carpa*, fruit, from the colour of the conspicuous olive green lirellae.

Graphina incisa A.W. Archer Figures 11 & 29

Sicut *Graphina colliculosa* (Mont.) Hale sed ascosporis majoribus et acidum norsticticum continens.

Type: AUSTRALIA. QUEENSLAND: Big Tableland, 26 km S of Cooktown, 15°43'S, 145°16'E, alt. 580 m, on *Alphitonia*, *H. Streimann 46361*, 11.xii.1990; holotype: CANB; isotype: B.

Thallus pale fawn, thin, corticolous, surface smooth and somewhat shiny; apothecia lirelliform, immersed, initially visible as pale, parallel lines on the thallus surface, splitting to reveal the brown epithecium, straight, curved or sinuous, 1-4(-6) mm long, 0.2-0.3 mm wide; proper exciple lacking; hymenium 80-100 µm tall, I-+ weak blue-violet; ascospores 8 per ascus, ellipsoid, hyaline, 29-40 µm long, 8-10 µm wide, 7-9 x 2-3 locular, I+ blue.

CHEMISTRY: norstictic acid.

SPECIMEN EXAMINED:
QUEENSLAND: type locality, *J.A. Elix 17241*, 4.vii.1984 (CANB); *ibid.*, on *Carnarvonia*, *H. Streimann 46324*, 11.xii.1990 (B, CANB).

Graphina incisa is characterised by the long thin, immersed lirellae, the absence of a proper exciple and the presence of norstictic acid. It is distinguished from the chemically similar *G. pertricosa* (Krempelh) Redinger (Redinger 1936) which also has narrow lirellae and similar ascospores, by the absence of a laterally carbonised proper exciple, present in *G. pertricosa*. The new species is distinguished from the fissurine species *G colliculosa* (Mont.) Hale (*cf.* Wirth & Hale, 1978, Plate 7e, p. 60) by the presence of norstictic acid; *G. colliculosa* contains salazinic acid. This latter species has been reported from Australia (Sipman & Streimann 1998) but the specimen on which the report was based (J.A. Elix 20879, CANB) contains protocetraric acid and is identified as *Graphina laevigata* (Müll. Arg.) A.W. Archer. *Graphina incisa* also resembles the new species *G. nothofagi* (*vide infra*) but the ascospores in that species are smaller. The new species is so far known only from the type locality in northern Queensland; reported substrates include *Alphitonia* and *Carnarvonia*.
The epithet *incisa*, is from the Latin *incisus*, cut into, a reference to the narrow lirellae which resemble incisions in the surface of the thallus.

Graphina lumbschii A.W. Archer Figures 12 & 30

Sicut *Graphina hiascens* (Fée) Müll. Arg. sed excipulo integro, ascosporiis longioribus et acida protocetraricum et norsticticum continens.

Type: AUSTRALIA. QUEENSLAND: Bartle Frere, Tinaroo falls, on twigs, *H.T. Lumbsch 5409c*, 15.viii.1987; holotype: CANB.

Thallus pale fawn, thin. corticolous, surface smooth and dull; apothecia lirelliform, inconspicuous, numerous, scattered, short and simple, sessile, lips closed, with a conspicuous thalline margin, 0.5-0.75 mm long, 0.4-0.6 mm wide; proper exciple completely carbonised; hymenium 150-200 µm tall, I-; ascospores 1, rarely 2, per ascus, narrow-ellipsoid, hyaline, 115-150 µm long, 15-20 µm wide, muriform, I+ blue-violet.

CHEMISTRY (hplc): norstictic acid (major), protocetraric acid (major), atranorin (minor), connorstictic acid (trace), salazinic acid (trace) and stictic acid (trace).

Graphina lumbschii is characterised by the short, simple lirellae with thalline margins, the completely carbonised proper exciple and the presence of norstictic and protocetraric acids. The new species resembles *Graphina hiascens* (Fée) Müll. Arg. (*vide supra*) which also has short, simple lirellae with thalline margins but is distinguished from that species by the completely carbonised proper exciple, the longer acospores [70-115 µm long (Wirth & Hale 1963); 80-100 µm long (Müller 1887a) in *G. hiascens*] and the presence of protocetaric acid, absent from *G. hiascens*. The differences between these species is shown in Table 1. *Graphina acharii* (Fée) Müll. Arg. is somewhat similar to *G. lumbschii* but possesses longer lirellae (to 6 mm) and lacks lichen compounds (Wirth & Hale 1978). The new species is distinguished from the chemically similar *G. rufopruinosa* (*vide infra*) by the absence of a carbonised exciple and the smaller ascospores in that species.

The new species is so far known only from the type specimen and is named after Dr. H.T. Lumbsch, University of Essen, who has made major contributions to the knowledge of Australian lichens.

Table 1. *Graphina* taxa with short simple lirellae and large ascospores found in Australia.

	G. hiascens	*G. lumbschii*	*G. lumbschii* var. *deficiens*
ascospore length [µm]	90-110	115-150	95-120
proper exciple carbonisation	lateral	complete	complete
chemistry	norstictic acid	norstictic & protocetraric acids	nil

Graphina lumbschii var. **deficiens** A.W. Archer

Sicut *Graphina lumbschii* A.W. Archer sed acida lichenica deficiens.

Type: AUSTRALIA. QUEENSLAND: Track to Lugger Bay, 17 km E of Tully, 17°57'E, 146°05'S, alt. 1 m, *H. Streimann 45427;* holotype: CANB.

Thallus off-white, thin, corticolous, surface smooth and dull; apothecia lirelliform, numerous, scattered, conspicuous, sessile, simple, 0.5-0.8 mm long. 0.3-0.5 mm wide, with a conspicuous thalline margin; proper exciple completely carbonised; hymenium 150-180 µm tall, I-ve; ascospores narrow-ellipsoid, hyaline, muriform, 95-120 µm long, (13-)15-20 µm wide, I+ve blue.

CHEMISTRY: no compounds found.

Graphina lumbschii var. *deficiens* is characterisd by the short (< 1 mm long), simple, sessile lirellae, the completely carbonised proper exciple and the absence of lichen compounds.

The variety is morphologically similar to *G. lumbschii*, *vide supra*, but lacks lichen compounds; externally the short simple lirellae resemble those of *Graphina hiascens* (Fée) Müll. Arg. The differences between the taxa are summarised in Table 1.
The variety is so far known only from the type specimen.

Graphina montoensis A.W. Archer Figures 13 & 31

Sicut *Graphina nanodes* (Vain.) Zahlbr. sed lirellis apertis et acidum norsticticum deficiens.

Type. AUSTRALIA. Queensland: Burnett Highway, 16 km SSW of Monto, 29°00'S, 151°13'E, alt. 350 m, on trunk of treelet in remnant, dry semi-tropical scrub forest on plateau, *H. Streimann 9845*, 16.i.1980; holotype: CANB; isotypes: H, NICH, US.

Thallus off-white, thin, corticolous, surface smooth and dull; apothecia lirelliform, numerous, conspicuous, crowded, immersed, open, straight, curved or sinuous, sometimes branched, 1-2(-03) mm long, 0.2-0.4 mm wide, with a negligible thalline margin; proper exciple laterally carbonised; hymenium 100-125 µm tall, I-ve; epithecium matt black, epruinose; ascospores 4(-5) per ascus, ellipsoid, hyaline, 40-50 µm long, (14-)16-22 µm wide, 12-14 x 2-4(-5) locular, I+ blue.

CHEMISTRY: no compounds found.

Graphina montoensis is characterised by the open lirellae, the laterally carbonised proper exciple and the absence of lichen compounds. The ascospores in *G. montoensis* are similar in size to those of *G. nanodes* and the lirellae in both species are laterally carbonised. However the apothecia are open, revealing a matt-black, epruinose epithecium in *G. montoensis* in contrast to the closed lirellae in *G. nanodes* [syntype: Philippines, Luzon, Baker 1253, TUR-V 27260]. In addition, *G montoensis* lacks lichen compounds in contrast to *G. nanodes*, the cited syntype of which contains norstictic acid. The new species somewhat resembles *G. subvelata* (Stirton) Zahlbr. but the ascospores in that species are slightly smaller, 35-45 µm long, with fewer locules, 8-11 x 2-3(-4) locular, and the lirellae are closed. The species is so far known only from the type collection.
The epithet, *montoensis*, is derived from the type locality, Monto.

Graphina nothofagi A.W. Archer Figures 14 & 32

Sicut *Graphina subaggregans* Müll. Arg. sed superficie nitidis, lirellis sessilis et epitheciis fuscis et epruinosis.

Type: AUSTRALIA. New South Wales: Tweed Range, Wiangaree Forest Drive, Antarctic Beech Walk, alt. 1000 m, on *Nothofagus moorei* in rain forest, *G. Kantvilas 644/88*, 3.viii.1988; holotype: NSW 219582; isotype: HO

Thallus pale olive green, thin, corticolous, surface smooth and shiny; apothecia lirelliform, numerous, sessile, straight, curved or sinuous, often branched, 2-6 mm long, 0.3-0.5 mm wide, lips initially closed, opening to reveal the brown, epruinose epithecium; proper exciple inconspicuous or lacking, uncarbonised; hymenium 75-100 µm tall, I-ve; ascospores 8 per ascus, irregularly 2-seriate, narrow ellipsoid, hyaline, 18-23 µm long, 6-8 µm wide, 5-6 x 2-3 locular, I+ blue.

CHEMISTRY: norstictic acid.

SPECIMEN EXAMINED:
New South Wales: 1 km W of Mount Banda Banda, alt 1050 m, on *Doryphora sassafras* in rain forest, *G. Kantvilas 499/88*, 6.vii.1988 (HO, NSW).

Graphina nothofagi is characterised by the long, thin lirellae, the absence of a carbonised exciple and the presence of norstictic acid. The Australian species *Graphina subaggregans* Müll. Arg., from Victoria (Archer 1999b), has similar ascospores and contains norstictic acid but this species has an off-white thallus with a dull surface and immersed lirellae with white pruinose epithecia and is thus distinct from *G. nothofagi*. The species is so far known from only two specimens from rainforest in northern New South Wales. The Hawaiian species *Graphina cremicolor* H. Magn. (Magnusson 1955) also has similar ascospores and contains norstictic acid but this species has immersed lirellae with a completely carbonised proper exciple.
The epithet *nothofagi* is from *Nothofagus*, the substrate of the holotype.

Graphina psoromica A.W. Archer Figures 15 & 33

Sicut *Graphis elixii* A.W. Archer sed ascosporis majoribus et muriformis.

Type: AUSTRALIA. New South Wales: New England National Park, Robinsons Knob Trail, *ca.* 83 km E of Armidale, on fallen tree, *A.W. Archer G 295*, 27.x.1998; holotype: NSW.

Thallus pale olive green, thin, corticolous, surface smooth and shiny; apothecia lirelliform, inconspicuous, initially fissurine, becoming sub-immersed to sessile, straight or curved, unbranched, 1-2 mm long, 0.2-0.4 mm wide, lips closed, with a conspicuous thalline margin; proper exciple ill-defined, pale yellow brown, dark brown above; hymenium 150-200 μm tall, I-ve; ascospores 8 per ascus, ellipsoid, hyaline, (22-)25-33 μm long, 11-15(-17) μm wide, 6 x 2 locular, I+ blue.

CHEMISTRY: psoromic acid.

SPECIMENS EXAMINED:
NEW SOUTH WALES: Track to Dangar Falls, 2 km N of Dorrigo, *A.W. Archer G 242*, 20.iv.1998 (NSW); Barrington Tops National Park, Thunderbolt Lookout, on *Nothofagus*, *G. Kantvilas 445/88*, 22.viii.1988 (HO, NSW).

Graphina psoromica is characterised by lirellae with an ill-defined proper exciple, the small ascospores and the presence of psoromic acid. It somewhat resembles *Graphina virginea* (Eschw) Müll. Arg. but that species has larger ascospores and contains hypostictic and salazinic acids (Harris 1995).
Graphina psoromica is distinguished from the chemically similar *Graphis elixii* A.W. Archer (Archer 1999b) by the smaller, transversely septate, 4-locular ascospores and the laterally carbonised proper exciple present in *Graphis elixii*.

Graphina radicicola A.W. Archer Figures 16 & 34

Sicut *Graphina polyclades* (Krempelh.) Müll. Arg. sed excipulo deficiens.

Type: AUSTRALIA. Queensland: Windsor Tableland, 45 km NW of Mossman, 16°15'S, 145°01'E, alt. 1200 m, on tree roots, *H. Streimann 29599*, 26.vi.1984 ; holotype: CANB; isotype: US.

Thallus dull olive-green, thin, corticolous, surface smooth and shiny; apothecia lirelliform, inconspicuous, initially fissurine, the lips thickening, opening and developing pale fawn margins, straight, curved or sinuous, unbranched, 1-3 mm long, 0.2-0.4 mm wide; proper exciple lacking; hymenium 150-170 µm tall, I-ve; ascospores initially 8 per ascus, 2-seriate, finally 4 per ascus, ellipsoid, hyaline, 35-40 µm long, 15-18 µm wide, 10-12 x 2-3 locular, I+ weak blue.

CHEMISTRY: stictic acid

Graphina radicicola is characterised by the fissurine lirellae, the absence of a proper exciple and the presence of stictic acid. The species resembles the Australian endemic species *Graphina polyclades* (Kremp.) Müll. Arg. in both chemistry and ascospores size but *G. radicicola* lacks the laterally carbonised proper exciple present in *G. polyclades*. The new species superficially resembles the Brazilian fissurine species *G. incrustans* (Fée) Müll. Arg. (Wirth & Hale 1978, p. 61, Fig. 8f) but is differentiated from that species by the ascospore size and the presence of stictic acid.
Graphina radicicola is so far known only from the type specimen.
The epithet *radicicola*, refers to the holotype substrate.

Graphina rufopruinosa A.W. Archer Figures 17 & 35

Sicut *Graphina pallido-ochracea* (Kremp.) Zahlbr. sed acida protocetraricum et norsticticum continens et pruina rufa.

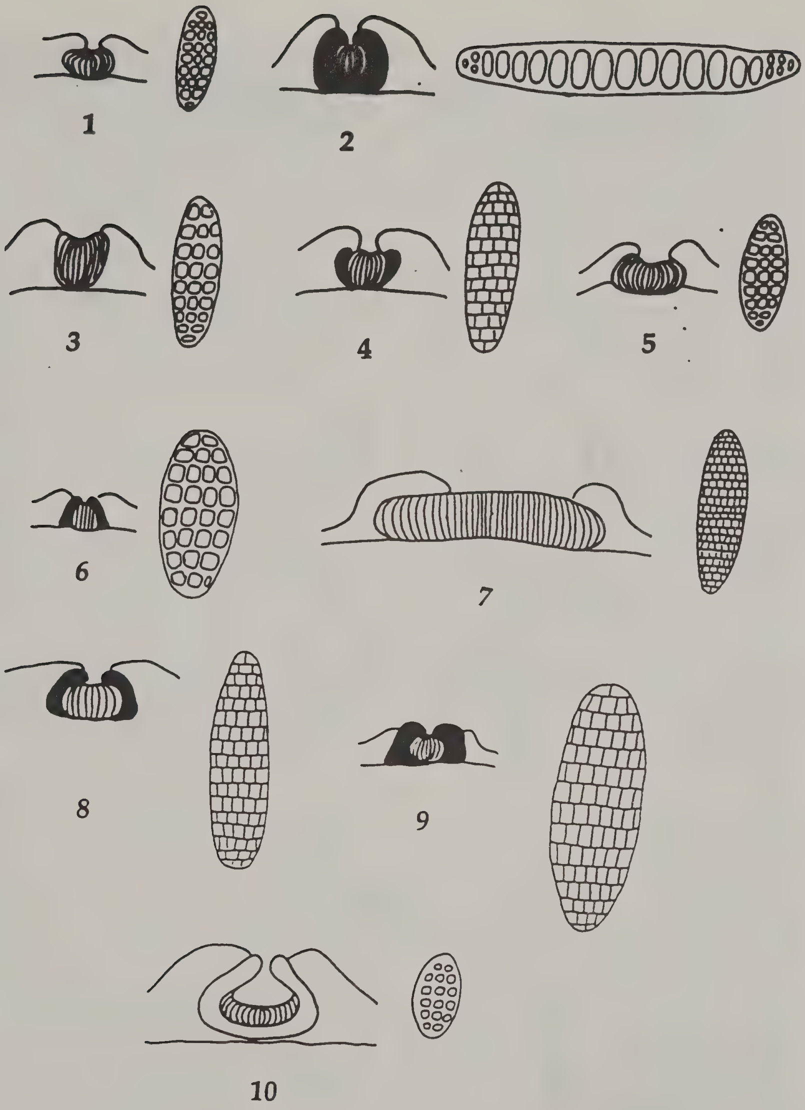
Type: AUSTRALIA. QUEENSLAND: Gordon Creek, 19km SW of Cape Weymouth, 12°43'S, 143°18'E, alt. 120 m, on semi-shaded treelet stem, *H. Streimann 56556*, 13.x.1995; holotype: CANB.

Thallus pale greenish white, thin, corticolous, surface sub-tartareous and dull; apothecia lirelliform, inconspicuous, immersed to sub-sessile, white, scattered or clustered, lips initially closed, becoming open, straight, curved or sinuous, rarely branched, with a conspicuous thalline margin, 1-3 mm long, 0.3-0.5 mm wide; proper exciple absent; hymenium I-ve, 150-200 µm tall; epithecium black, reddish brown pruinose; ascospores ellipsoid, hyaline, (105-)120-150(-170) µm long, 30-42 µm wide, muriform, I+ blue-violet.

CHEMISTRY (hplc): protocetraric acid (major), norstictic acid (minor), salazinic acid (minor), stictic acid (trace), subvirensic acid (trace), virensic acid (trace) and methyl virensate (trace).

SPECIMENS EXAMINED:
QUEENSLAND: Ingham-Kangeroo Hill Road, 38 km SW of Ingham, *J.A. Elix 20385*, 19.vi.1986 (CANB); Mount Whitfield, Cairns, *J.A. Elix 2557*, 24.viii.1976 (CANB); road from Gordonvale to Yarrabah, ca. 10 km E of Cairns, *H.T. Lumbsch 11158s*, 1.viii.1996 (herb. Lumbsch).

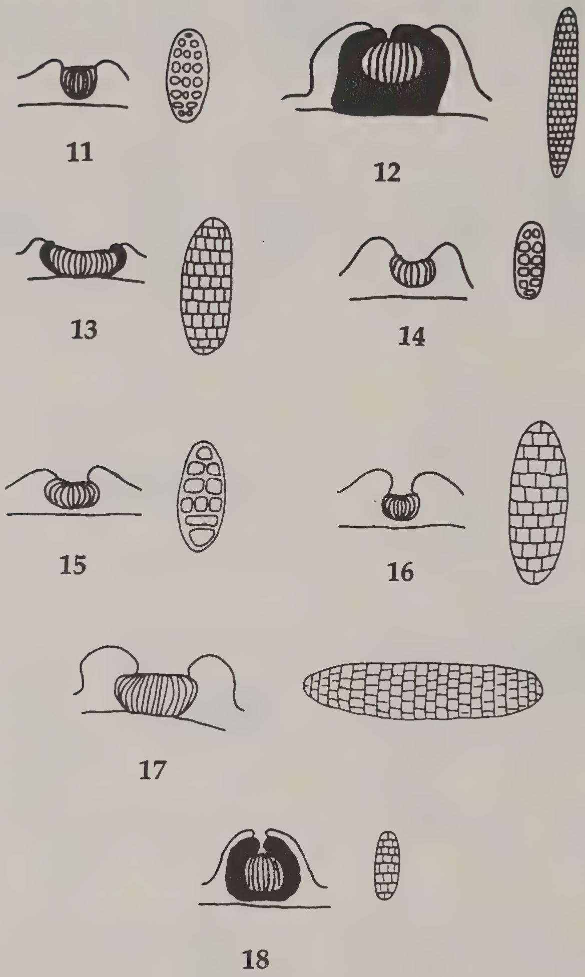
Graphina rufopruinosa is characterised by inconspicuous, narrow, white lirellae with reddish brown pruinose, black epithecia, muriform ascospores and the presence of protocetraric and norstictic acids. It resembles *Graphina pallido-ochracea* (Kremp.) Zahlbr. but is distinguished from that species by the presence of protocetraric and norstictic acids (*G. pallido-ochracea* contains stictic acid), the reddish brown pruina, the slightly wider ascospores (24-32 µm wide in *G. pallido-ochracea*) and the conspicuous thalline margins. *Graphina rufopruinosa* is distinguished from the chemically similar new species, *G. lumbschii* (*vide supra*), by the presence of a completely carbonised proper exciple and larger ascospores in that species. *Graphina rufopruinosa* is so far known only from northern Queensland. The only reported substrate is *Casuarina*.
The epithet *rufopruinosa* refers to the reddish brown pruina on the epithecium.



Figures 1-10. New Australian *Graphina* species.

Fig.1 *Graphina abdita*; Fig.2 *G. aquilonia*; Fig.3 *G. atramontana*; Fig.4 *G. atrocelata*
Fig.5 *G. atronitens*; Fig.6 *G. borealis*; Fig.7 *G. boweniana*; Fig.8 *G. celata*;
Fig.9 *G. daintriensis*; Fig.10 *G. elaiocarpa*.

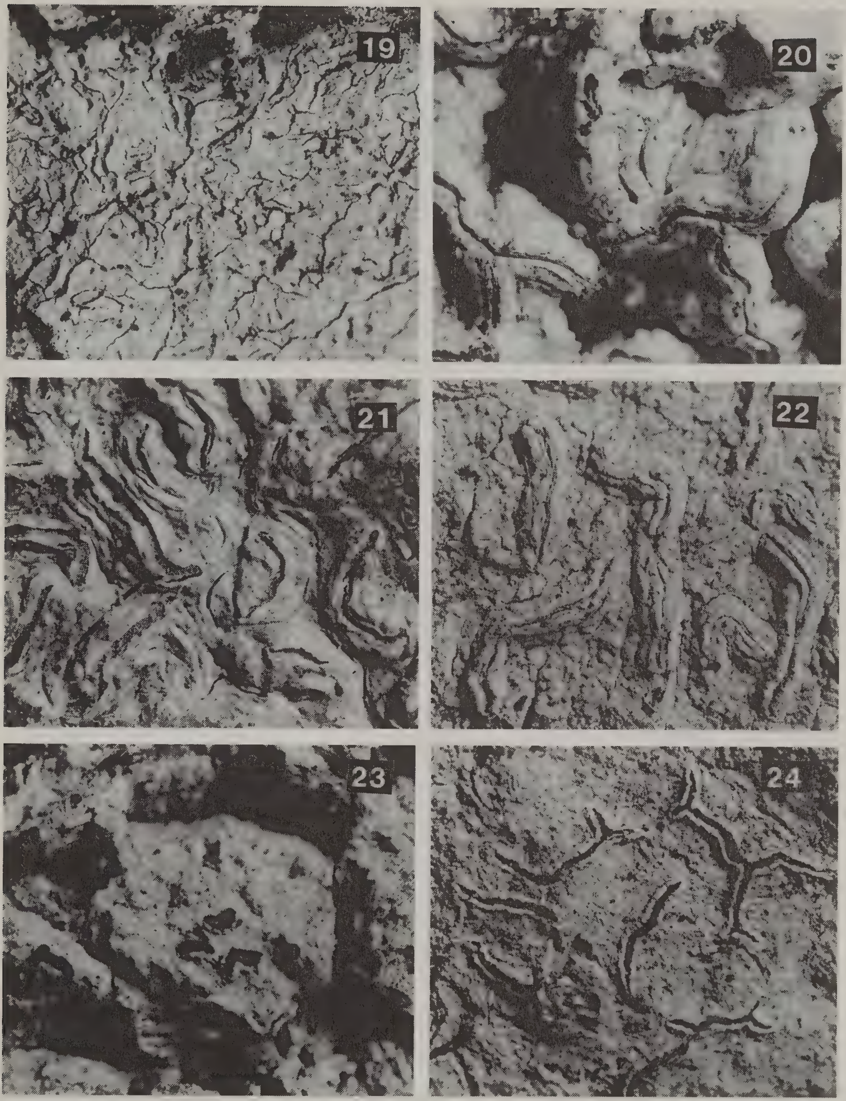
Lirellae cross-sections *ca*. x 40; ascospores *ca*. x 440 except Figs. 4 & 7, *ca*. x 175



Figures 11-18. New Australian *Graphina* species.

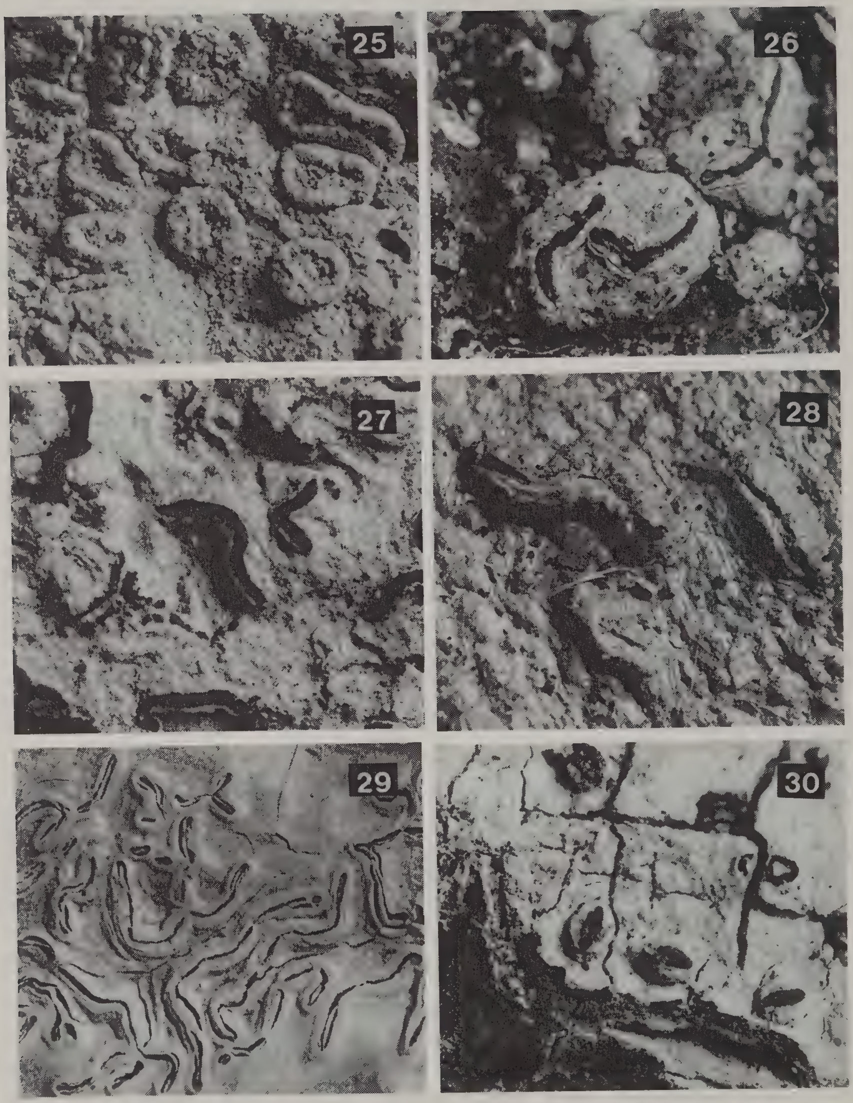
Fig.11 *Graphina incisa*; Fig.12 *G. lumbschii*; Fig.13 *G. montoensis*; Fig.14 *G. nothofagi*; Fig.15 *G. psoromica*; Fig.16 *G. radicicola*; Fig.17 *G. rufopruinosa*; Fig.18 *G. salazinica*.

Lirellae cross-sections ca. x 40; ascospores ca. x 440 except Fig.12, ca. x 175



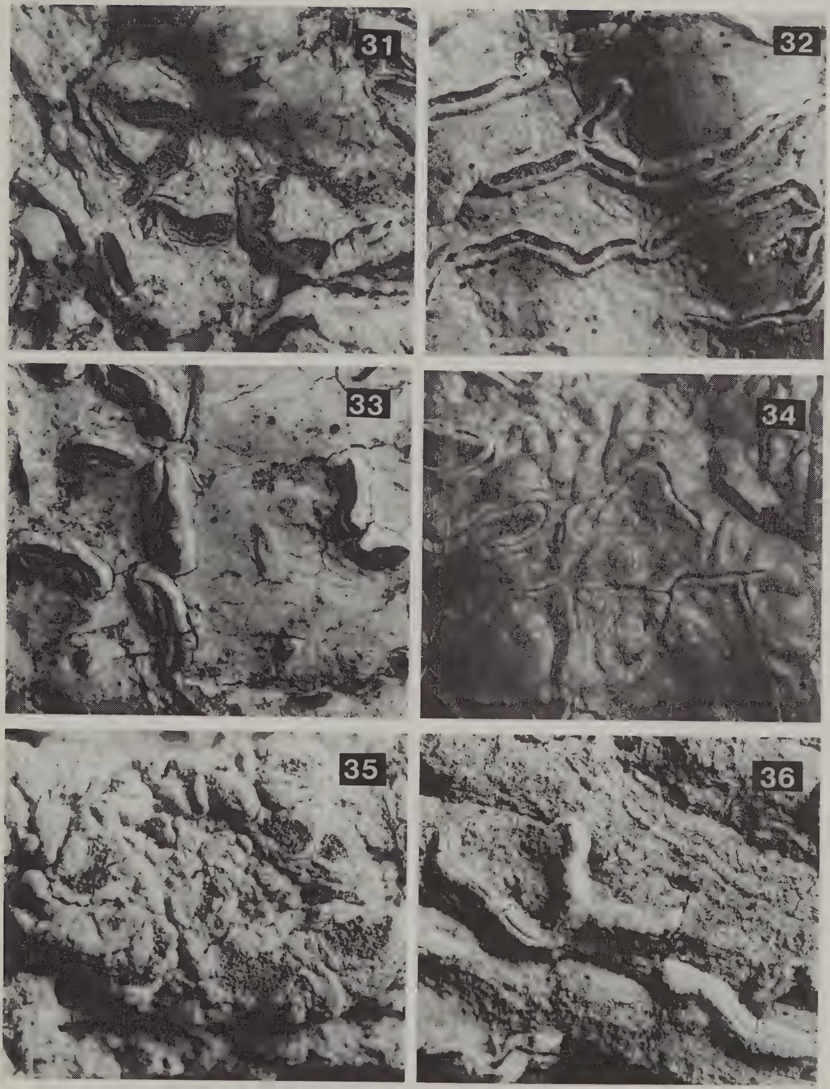
Figures 19-24. New Australian *Graphina* species. Holotypes (14 x magnification)

Fig.19 *Graphina abdita*; Fig.20 *G. aquilonia*; Fig.21 *G. atramontana*;
Fig.22 *G. atrocelata*; Fig.23 *G. atronitens*; Fig.24 *G. borealis*



Figures 25-30. New Australian *Graphina* species. Holotypes (14 x magnification)

Fig.25 *G. boweniana*; Fig.26 *G. celata*; Fig.27 *G. daintriensis*;
Fig.28 *G. elaiocarpa*; Fig.29 *G. incisa*; Fig.30 *G. lumbschii*;



Figures 31-36. New Australian *Graphina* species. Holotypes (14 x magnification)

Fig.31 *G. montoensis*; Fig.32 *G. nothofagi*; Fig.33 *G. psoromica*; Fig.34 *G. radicicola*; Fig.35 *G. rufopruinosa*; Fig.36 *G. salazinica*.

Graphina salazinica A.W. Archer Figures 18 & 36

Sicut *Graphina marcescens* (Fée) Müll. Arg. sed excipulo integro et ascosporiis majoribus.

TYPE: AUSTRALIA. NEW SOUTH WALES: Conglomerate State Forest, Anderson Mountain Road, *ca.* 24 km NNW of Coffs Harbour, on palm tree, *A.W. Archer G 189*, 19.iv.1998; holotype: NSW.

Thallus greyish green, thin, corticolous, surface smooth and dull; apothecia lirelliform, conspicuous, white, sessile, straight or curved, rarely branched, 1-4 mm long, 0.25-0.3 mm wide, with a conspicuous powdery thalline margin; proper exciple completely carbonised, concealed in the thalline margin; hymenium 100-120 µm tall, I-ve; ascospores 8 per ascus, ellipsoid, hyaline, muriform, 19-23 µm long, 7-8 µm wide, 6-8 x 1-2 locular, I+ blue.

CHEMISTRY (hplc): salazinic acid (major), consalazinic acid (trace), norstictic acid (trace) & protocetraric acid (trace).

Graphina salazinica is characterised by the conspicuous lirellae and the presence of salazinic acid (see Table 2). It is differentiated from the chemically similar species, *G. colliculosa* (Mont.) Hale and *G. marcescens* (Fée) Müll. Arg. (which also has a powdery thalline coating) by the smaller ascospores and the absence of a completely carbonised exciple in those species (Wirth & Hale 1978). *Graphina marcescens* (Fée) Müll. Arg. has recently been reported from Queensland (Staiger & Kalb 1999).

Table 2. *Graphina* and *Graphis* species with salazinic acid.

	Exciple carbonisation	ascospore length (µm)
Graphina salazinica A.W. Archer	complete	19-23
Graphina marcescens (Fée) Müll. Arg.	lateral	12-16
Graphina colliculosa (Mont.) Hale	nil	11-16
Graphis ficicola Vain.	complete	16-28
Graphis nematoides Leighton	lateral	18-25

Superficially the new species resembles *Graphis afzelii* Ach. but is distinguished from that species by the muriform ascospores and the presence of salazinic acid. The new species is so far known only from the type specimen. *Graphina salazinica* is a sporomorph (*sensu* With & Hale 1978) of *Graphis ficicola* Vain. A comparison of *Graphis* and *Graphina* species containing salazinic acid is shown in Table 2.

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Key to Australian *Graphina* species

Saxicolous species.

1. Lirellae immersed; ascospores 69-90 µm long, proper exciple laterally carbonised
....*G. celata* A.W. Archer
Lirellae sessile; ascospores > 40 µm long 4

2. Norstictic acid present; proper exciple completely carbonised ascospores 40-55
µm long; .... *G. saxicola* Müll. Arg.
Stictic acid present; proper exciple laterally carbonised; ascospores (50-)60-90 µm
long, 12-16 x 2-4 locular ....*G. fissofurcata* (Leight.) Müll. Arg.

Corticolous species.

1. Lichen compounds absent ....**Group A**
Lichen compounds present 2

2. Salazinic acid or protocetraric acid present 3
Norstictic, stictic acid or psoromic acid present..8

3. Salazinic acid present...4
Protocetraric acid present 5

4. Ascospores 19-23 µm long, 6 x 2 locular; proper exciple completly carbonised.....
....*G. salazinica* A.W. Archer
Ascospores 12-14 µm long, 4-5 x 2 locular; proper exciple laterally carbonised.....
.... *G. marcescens* (Fée) Müll. Arg.

5. Ascospores < 15 µm long; only protocetraric acid present 6
Ascospores > 100 µm long; protocetraric and norstictic acids present...............7

6. Lirellae immersed, lips closed, no thalline margin; ascospores 9-14 µm long,
4-6 x 2 locular.. *G. pertenella* (Stirton) Shirley
Lirellae sessile, lips open, conspicuous thalline margin; ascospores 11-12 µm ......
long, 4 x 2 locular .... *G. laevigata* (Müll. Arg.) A.W. Archer

7. Proper exciple completely carbonised; ascospores 130-150 µm long.................
....*G. lumbschii* A.W. Archer
Proper exciple lacking; ascospores 130-170 µm long. *G. rufopruinosa* A.W. Archer

8. Psoromic acid present; ascospores 22-33 µm long.......*G. psoromica* A.W. Archer
Stictic acid present..**Group B**
Norstictic acid present...**Group C**

Group A; corticolous, lacking lichen compounds.

1. Proper exciple lacking; lirellae immersed to subimmersed, discs epruinose, black,
shiny; ascospores 30-40 µm long, 8-10 x 2-4 locular ....
....*G. atronitens* A.W. Archer
Proper exciple present..2

2. Proper exciple red-brown, complete, uncarbonised.................................3
Proper exciple partly or completely carbonised 4

3. Ascospores 21-28 µm long, 4-5 x 2-4 locular; lirellae not sulcate....................
.... *G. elaiocarpa* A.W. Archer
Ascospores 60-70 µm long; lirellae sulcate...*G. repleta* (Stirton) Shirley var. *repleta*

4. Proper exciple completely carbonised..5
Proper exciple laterally or apically carbonised 8

5. Ascospores > 50 µm long 6
Ascospores 19-25 µm long, 6-8 x 2 locular............. *G. hartmanniana* Müll. Arg.

6. Lirellae ≤ 1 mm long, thalline margin conspicuous; ascospores 90-120 µm long,
completely muriform ....*G. lumbschii* var. *deficiens* A.W. Archer
Lirellae ≥ 2mm long, thalline margin inconspicuous.................................7

7. Ascospores 100-115 µm long, 24-26 x 2 locular, muriform in terminal locules .....
only .... *G. acharii* (Fée) Müll. Arg.
Ascospores 60-86 µm long, completely muriform ......*G. daintriensis* A.W. Archer

8(5). Proper exciple apically carbonised; ascospores 56-80 µm long, 12-14 x 2-4
locular; lirellae closed .... *G. contorta* Müll. Arg.
Proper exciple laterally carbonised;...9

9. Ascospores 120-140 µm long; proper exciple concealed by thalline margin
.... *G. atrocelata* A.W. Archer
Ascospores < 100 mm long 10

10. Lirellae immersed.. 11
Lirellae not immersed; ascospores 60-86 µm long, 16-18 locular, muriform.........
....*G. daintriensis* A.W. Archer

11. Lirellae open; ascospores 40-50 µm long, 12-14 x 2-4 locular........................
....*G. montoensis* A.W. Archer
Lirellae closed.. 12

12. Ascospores 19-24 µm long, 5-6 locular ....*G. tenuirima* Shirley
Ascospores 35-45 µm long, 8-11 locular................. *G. subvelata* (Stirt.) Zahlbr.

Group B; corticolous; stictic acid present.

1. Proper exciple uncarbonised 2
Proper exciple laterally carbonised 7

2. Lirellae sulcate;...3
Lirellae not sulcate...4

3. Ascospores 100-150 µm, muriform........ *G. repleta* var. *macrospora* A.W. Archer
Ascospores 45-65 µm long........................*G. repleta* var. *stictica* A.W. Archer

4. Lirellae open...5
Lirellae closed..6

5. Lirellae sessile; ascospores 80-132 µm long, muriform ....
....*G. pallido-ochracea* (Kremp.) Zahlbr.
Lirellae immersed; ascospores 35-40 µm long, 10-12 x 2-4 locular ....
.... *G. radicicola* A.W. Archer

6. Ascospores 28-35 µm long, 8-10 x 2-3 locular............... *G. abdita* A.W. Archer
Ascospores 18-25 µm long, 6-9 x 2 locular................ *G. gyridia* (Stirt.) Zahlbr.

7. Ascospores (50-)60-90 µm long, 12-16 locular, lirellae conspicuous ....
.... *G. fissofurcata* (Leight.) Müll. Arg.
Ascospores 37-50 µm long, 8-10 locular, lirellae inconspicuous ....
.... *G. polyclades* (Kremp.) Müll. Arg.

Group C; corticolous, norstictic acid present.

1. Proper exciple lacking...2
Proper exciple present, completely or laterally carbonised 7

2. Ascospores < 40 µm long,...3
Ascospores > 40 µm long 5

3. Ascospores 16-23 µm long, 5-8 x 2-3 locular 4
Ascospores 29-40 µm long, 7-9 x 2-3 locular .... *G. incisa* A.W. Archer

4. Ascospores 16-20 µm long, 6-8 x 2 locular; thallus surface dull; epithecium pruinose
.... *G. subaggregans* Müll. Arg.
Ascospores 18-23 µm long, 5-6 x 2-3 locular; thallus surface shiny; epithecium epruinose .... *G. nothofagi* A.W. Archer

5. Ascospores < 115 µm long..6
Ascospores (115-)137-175 µm long; epithecium white pruinose......................
.... G. *boweniana* A.W. Archer

6. Ascospores 78-112 µm long, muriform .... *G. mendax* Nyl.
Ascospores 36-52 µm long, 7-9 x 3-4 locular .... *G. atramontana* A.W. Archer

7(1). Proper exciple laterally carbonised 7
Proper exciple completely carbonised; lirellae > 2 mm long; ascospores 85-105 µm long, terminally muriform .... *G. aquilonia* A.W. Archer

8. Ascospores *ca.* > 95 µm long, ± densely muriform.....................................9
Ascospores *ca.* < 95 µm long, not densely muriform.................................. 10

9. Ascospores 100-145 µm long, 25-38 µm wide, densely muriform; lirellae subimmersed, long, branched................................ *G. palmicola* Müll. Arg.
Ascospores 90-110 µm long, 15-20 µm wide, 24 x 3-6 locular; lirellae conspicuously sessile, short, simple .... *G. hiascens* (Fée) Müll. Arg.

10. Ascospores 80-95 µm long, 16-18 locular; lirellae smooth, immersed ....
.... *G. subtartaraea* Müll. Arg.
Ascospores < 10 locular, < 50 µm long 11

11. Ascospores (20-)25-35 µm long, 4-8 x 2-3(4) locular..................................
.... *G. gracilescens* (Vainio) Zahlbr.
Ascospores 37-51 µm long, 6-8 x 2-4 locular .... *G. borealis* A.W. Archer

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MYXOMYCETES OF SONORA, MEXICO. I

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ABSTRACT

The first study of the Myxomycetes from the Mexican state of Sonora is presented. Seventeen taxa are new records for the Sonoran Mycobiota. *Diachea subsessilis*, *Didymium rubeopus* var. *rubeopus* and *Trichia affinis* are first records for Mexico. From a chorological point of view two taxa are interesting: *Hemitrichia parviverrucospora status* and *comb. nov.* and *Metatrichia horrida*. SEM photographs of the most important characteristics of these five species are provided.

Key words: Chorology, Taxonomy, Mexico, Liceales, Physarales, Stemonitales, Trichiales.

INTRODUCTION

Two hundred and sixty three taxa (254 species and 9 varieties) of Myxomycetes from Mexico are known (Illana *et al.*, 2000). The records have a scattered distribution throughout this country. Some Mexican states such as Baja California, Tlaxcala, Jalisco and Veracruz are well studied, others have few or no records at all. Sonora is located within the second group. *Fuligo cinerea* (Schwein.) Morgan is the only Myxomycete known from this state, cited by Braun & Keller in 1976. This is the first contribution to the knowledge of the Myxomycetes of Sonora, with all taxa included here being new records for the state. Part of this study was presented in the Second International Congress on the Systematics and Ecology of Myxomycetes (Pérez-Silva *et al.*, 1996).

MATERIAL AND METHODS

The specimens were collected in several municipalities of Sonora, mainly from Alamos and Yécora. The localities are between 400-1600 m altitude with different types of vegetation: tropical deciduous forest, oak woodland, pine-oak woodland, pine forest, *Quercus-Juniperus-Pinus* forest, and riparian vegetation. The collections are kept in the National Herbarium of the "Instituto de Biologia", UNAM (MEXU) and the mushroom collection of the "Centro de Estudios Superiores del Estado de Sonora" (CESUES). The material studied by C.I. & G.M. was mounted in Hoyer's medium. These permanent slides are deposited in the Herbarium of the "Departamento de Biología Vegetal, Universidad de Alcalá, Alcalá de Henares, Madrid" (AH). SEM photographs were taken in the University of Alcalá using the critical point drying technique (Castillo *et al.,* 1998). The chorology is based on Illana *et al.* (2000).

LIST OF SPECIES

Arcyria denudata (L.) Wettst.

Collections examined. SONORA: On dead wood, in oak woodland and *Quercus-Juniperus-Pinus* forest. Yécora Municipality, km 258 Hermosillo to Yécora road, *leg.* M. Esqueda & M. Amaya, 15.VIII.1992, MEXU 24366, CESUES 857. Km 3.5 Yécora to Sahuaripa way, *leg.* A. Armenta, 5.X.1995, MEXU 24665; duplicate as permanent slide in AH 19596.

Observations. *Arcyria denudata* is a common species in Mexico. It is easily recognized by its red, stipitate sporocarps, shallow funnel-shaped calyculus, and capillitum attached to the calyculus.

Arcyria incarnata (Pers.: J. F. Gmel.) Pers.

Collections examined. SONORA: On dead wood, in tropical deciduous forest and pine forest. Alamos Municipality, border of Cuchujaqui river, *leg.* E. Pérez-Silva & M. Esqueda, 11.IX.1994, MEXU 24660, CESUES 1711. Yécora Municipality, km 3.4 Yécora to Las Cabañas way, *leg.* E. Pérez-Silva & T. Herrera, 4.X.1996, MEXU 24365, CESUES 1963.

Observations. *Arcyria incarnata* is a very common species. It is easy to recognize by its pinkish sporocarps, shallow saucer-shaped calyculus, short stalk, and capillitium loosely attached to the calyculus.

Arcyria obvelata (Oeder) Onsberg

Collections examined. SONORA: On dead wood. Huásabas Municipality, in urban zone of Huásabas, *leg.* E. Pérez-Silva & M. Esqueda, 14.VIII.1991, MEXU 23227.

Observations. This species is widely distributed in Mexico. The main chararacteristics are its yellow to ochraceous sporocarps and expanding capillitium which is loosely attached to the calyculus.

Craterium leucocephalum (Pers.: J. F.Gmel.) Ditmar

Collections examined. SONORA: On dead leaves, in tropical deciduous forest. Alamos Municipality, Las Uvalamas ranch, near a small stream, *leg.* E. Pérez-Silva & M. Esqueda, 12.IX.1994, MEXU 24120, CESUES 1863.

Observations. This is another species that is widely distributed in Mexico. *Craterium leucocephalum* can be identified by its whitish, cylindrical sporocarps, short stalk and circumscissile dehiscence leaving the peridium a persistent elongated basal cup.

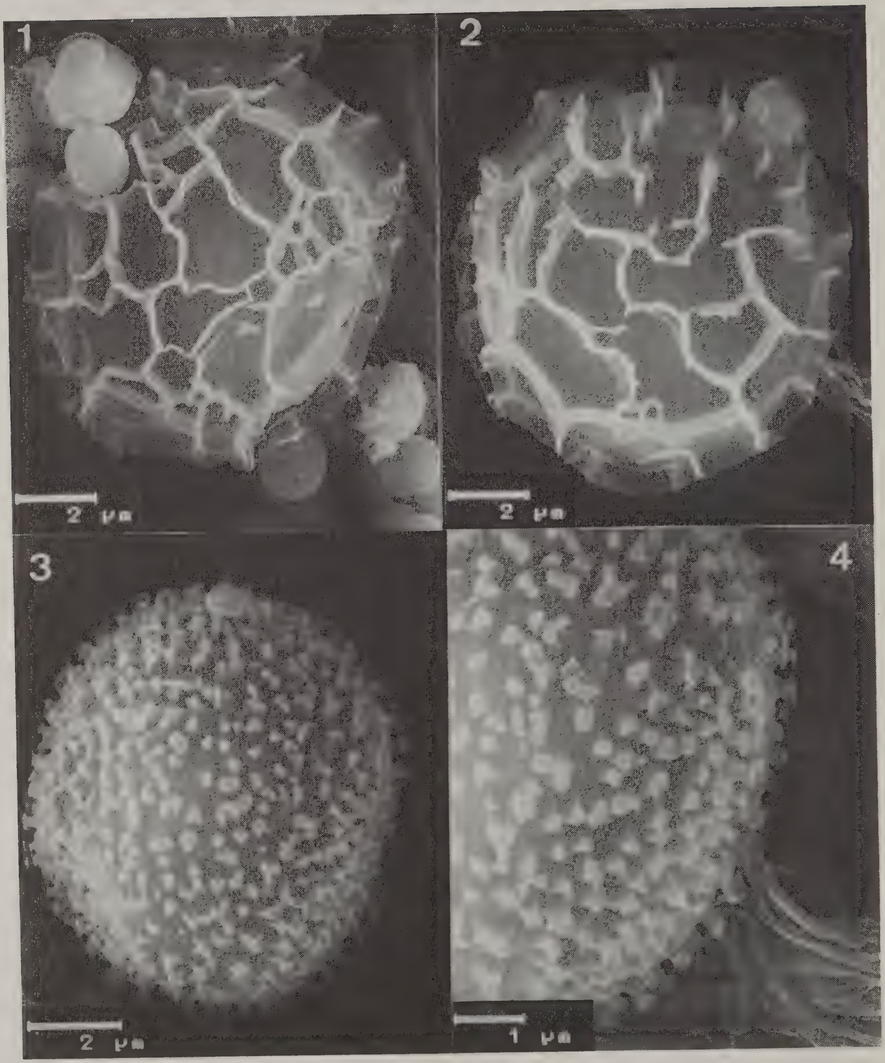
Cribraria cancellata (Batsch) Nann.-Bremek.

Collections examined. SONORA: On dead wood, in pine forest. Yécora Municipality, km 3.4 Yécora to Las Cabañas way, *leg.* M.A. Pestaño, 12.IX.1995, MEXU 24664.

Observations. This species is common in Mexico. It has been also reported from Mexico as *Dictydium cancellatum* (Batsch) T. Macbr. It is distinguished by the reddish brown sporocarps and the peridial net with ribs extending from the apex to the base of the sporotheca.

Diachea subsessilis Peck Figs. 1-2

Collections examined. U.S.A.: On dead leaves, in tropical deciduous forest. Holotype Herb. New York State Museum NYS 263, Adirondack Mountains of New York, *leg.* C. H. Peck. SONORA: Alamos Municipality, La Sierrita ranch, *leg.* E. Pérez-Silva & M. Esqueda, 13.IX.1994, MEXU 24360; duplicate as permanent slide in AH 19597. OAXACA: Tuxtepec Municipality, *leg.* M. A. Martínez-Alfaro, 2.XI.1969, MEXU 6840. PUEBLA: Villa Juárez Municipality, 2 km NW of Villa Juárez, *leg.* J. J. Gamboa, 14.V.1967, MEXU 8739.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Figs. 1-2. ***Diachea subsessilis*** Peck (AH 19597): 1-2. Spores. **Figs. 3-4.** ***Didymium rubeopus*** G. Moreno, Castillo & Illana (AH 19603): 3. Spore. 4. Detail of spore ornamentation.

Sporocarps crowded, stalked. Sporotheca globose to depressed globose, iridescent gray or bluish. Hypothallus grayish white, reticulate, scanty. Stalk conic, two or three times longer than the sporotheca, white, with calcic granules (1-2 µm diam.). Capillitium lax, 1-1.5 µm diam., brownish threads united into a net, colorless free ends and dichotomously ramifed, with some dark nodules. Spores 8-10 µm diam., dark brown in mass, purplish by transmitted light, globose, irregularly reticulate.

Observations. *Diachea subsessilis* is a species that is easily recognized by its globose sporocarps, white and calcareous stalk, and reticulate spores (Figs.1-2). This is the first record for Mexico.

Didymium rubeopus* var. *rubeopus G. Moreno, Castillo & Illana Figs. 3-4

Collections examined. SONORA: On *Pinus* leaves, in pine forest within an urban border. Yécora Municipality, urban border of Yécora town, near the road, *leg.* O. Gutiérrez, 24.X.1993, MEXU 24348, CESUES 1303; duplicate as permanent slide in AH 19603.

Observations. This species was recently described as new to science by Moreno *et al.* (1997b). It is characterized by its globose sporocarps, reddish stalk, capillitium formed by smooth, delicate, flexuous, 2-4 µm diam. filaments, and spores 9-11 µm diam., spinose (pilate under SEM, Figs. 3-4). Differences between *D. laxifilum* G. Lister & Ross and the variety *Didymium rubeopus* var. *albocapillitium* G. Moreno, Castillo, Illana & Lizárraga were previously documented by Moreno *et al.* (1997b). This is the first record for Mexico.

Fuligo septica (L.) F. H. Wigg.

Collections examined. SONORA: On dead or rotten wood, in urban area and tropical deciduous forest. Alamos Municipality, Las Uvalamas ranch, *leg.* E. Pérez-Silva & M. Esqueda, 2.IX.1994, MEXU 24662, CESUES 1808. Hermosillo Municipality, urban area of Hermosillo, *leg.* E. Pérez-Silva & M. Esqueda, 2.IX.1994, MEXU 24111.

Observations. This cosmopolitan species is widely distributed in Mexico. The pulvinate aethalia vary greatly in shape, size and color, but are usually large, white, greenish, brown or yellow, producing a dull black mass of spores.

Hemitrichia clavata (Pers.) Rostaf. **var.** ***calyculata*** (Speg.) Yamam.

Collections examined. SONORA: On bark and dung, in *Quercus-Juniperus-Pinus* forest. Yécora Municipality, km 3.5 Yécora to Sahuaripa way, *leg.* E. Pérez-Silva & M. Esqueda, 13.VIII.1994, MEXU 24368; *leg.* M. A. Pestaño, 8.IX.1995, MEXU 24364; 3.X.1995, MEXU 24663; duplicate as

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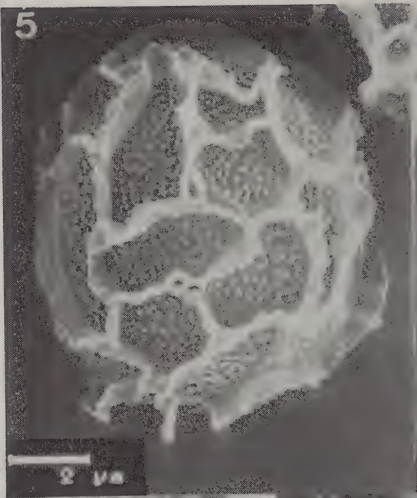

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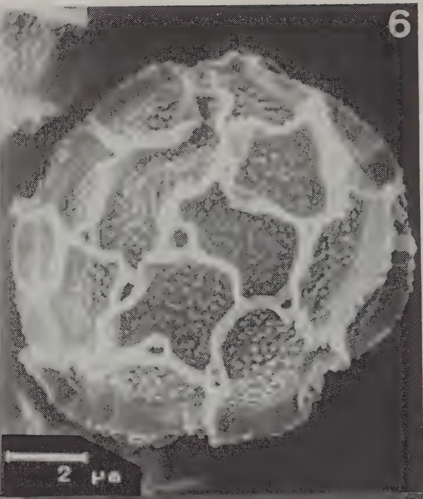

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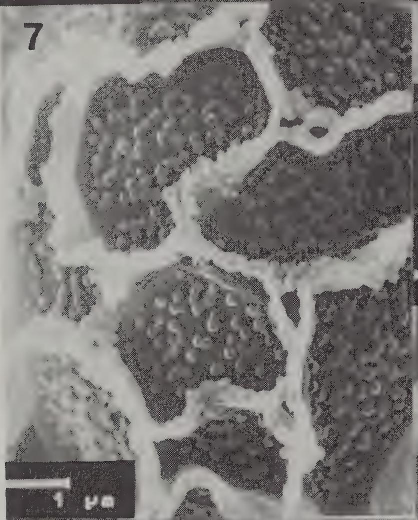

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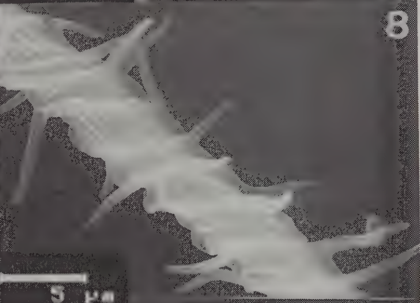

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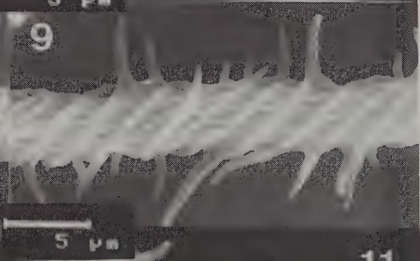

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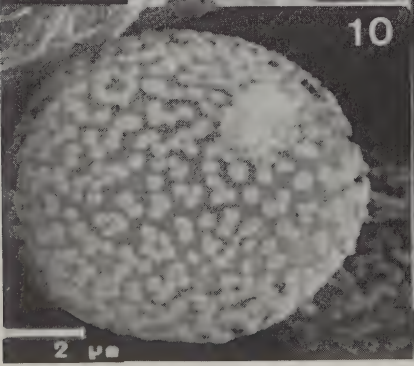

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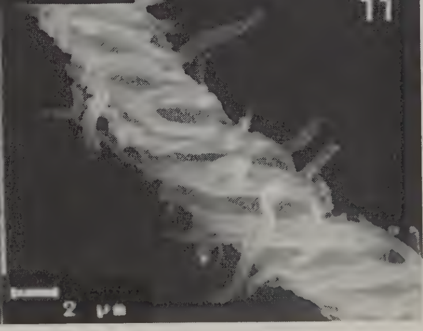


permanent slide in AH 19598.

Observations. *Hemitrichia clavata* var. *calyculata* is a common species in Mexico. It is characterized by its pyriform sporothecae with a cylindrical stalk; peridium partially evanescent in the apex, remaining as a calyculus; capillitium and spores yellow; capillitium with tubes of 4-5 µm diam., ornamented with 4-5 spirals and fine spines; and spores of 7-9 µm diam. ornamented with fine spines which are united into a delicate reticulum with irregular meshes. According to Eliasson & Keller (1999), this species is reported for the first time on cow dung.

Hemitrichia parviverrucospora (Lizárraga, G. Moreno & Illana) G. Moreno & Illana, *status et comb. nov.* Figs. 5-9

≡ *H. serpula* var. *parviverrucospora* Lizárraga, G. Moreno & Illana, *Ann. Bot. Fennici* 36: 189. 1999.

Collections examined. SONORA: On dead wood, in tropical deciduous forest. Alamos Municipality, La Sierrita ranch, *leg.* E. Pérez-Silva & M. Esqueda, 13.IX.1994, MEXU 24150; duplicate in permanent slide in AH 19599.

Observations. *Hemitrichia parviverrucospora* forms branched to reticulate plasmodiocarps. Microscopically is characterized by the capillitium being ornamented with 3-4 spiral bands and spines which are frequently 4-7 µm long, (Figs. 8-9); spores reticulate with small warts within the meshes, being visible only under SEM (Figs. 5-7). *H. serpula* (Scop.) Rostaf. is distinguished from the former species by the capillitium with fewer, shorter spines (rarely more than 3-5 µm long), and reticulate spores without warts within the meshes. Many collections have been found in the subtropical forests of Mexico. The consistent ornamentation of the capillitium and spores that may be observed by both LM and SEM encourage us to propose this new combination. *H. parviverrucospora* has been cited only from central Africa and Mexico (Baja California Sur and Sinaloa) (Lizárraga *et al.* 1998, 1999).

Lycogala epidendrum (L.) Fr.

Collections examined. SONORA: On dead wood, in riparian vegetation, oak woodland and pine forest. Huásabas Municipality, border of the Bavispe river, *leg.* E. Pérez-Silva & M. Esqueda, 14.VIII.1991, CESUES 1859, MEXU 23226. Granados Municipality, near the Bavispe river, *leg.* E.

Figs. 5-9 ***Hemitrichia parviverrucospora*** (Lizárraga, G. Moreno & Illana) G. Moreno & Illana (AH 19599): 5-6. Spore. 7. Detail of warts. 8-9. Capillitium. **Figs. 10-11** ***Metatrichia horrida*** Ing (AH 19601): 10. Spore. 11. Capillitium.

Pérez-Silva & M. Esqueda, 14.VIII.1991, MEXU 24357. Yécora Municipality, Rincón del Güérigo, km 251 Hermosillo to Yécora road, *leg.* E. Pérez-Silva & M. Esqueda, 16.VIII.1991, MEXU 23355; *leg.* M. Esqueda & M. Amaya, 16.VIII.1992, MEXU 24358, CESUES 899. Mesa Grande, km 17 Yécora to Santa Rosa way, *leg.* E. Pérez-Silva & M. Esqueda, 15.VIII.1991, MEXU 24359, CESUES 199.

Observations. This species has been frequently reported from Mexico.

Lycogala flavofuscum (Ehrenb.) Rostaf.

Collections examined. SONORA: On dead wood, in riparian vegetation. Arizpe Municipality, border of the Arizpe town, *leg.* E. Pérez-Silva & M. Esqueda, 10.IX.1993, MEXU 24353 duplicate as permanent slide in AH 19600.

Observations. This species is not frequent in Mexico. This species is distinguished by its large aethalia (2-5 cm) with a thick and brittle peridium, and the tubular threads of the pseudocapillitium which are strongly sculptured with spinules.

Metatrichia horrida Ing Figs. 10-11

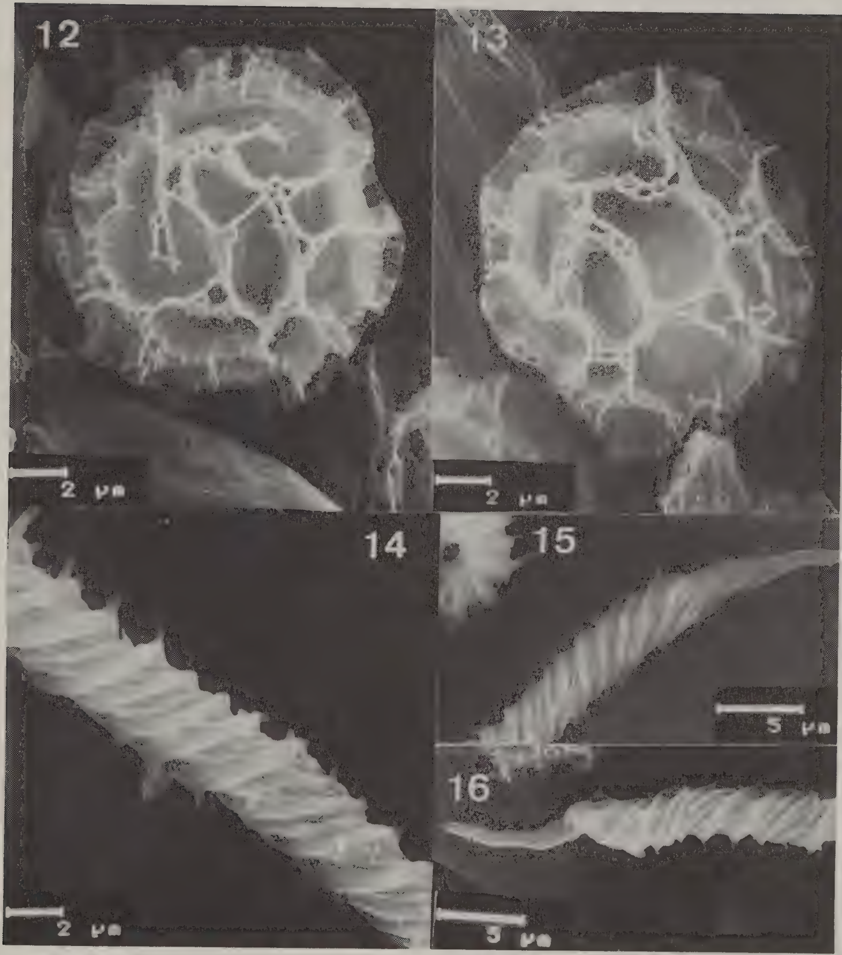
Collections examined. SONORA: On dead wood, in oak woodland. Yécora Municipality, Rincón del Güérigo, km 251 Hermosillo to Yécora road, *leg.* E. Pérez-Silva & M. Esqueda, 26.XI.1991, MEXU 23438; duplicate as permanent slide in AH 19601.

Sporocarps clustered in extensive groups, sessile or short stalked, dark brown to ferruginous or reddish brown to dull crimson, 1-2.5 mm long, peridium persistent, remaining as a very deep calyculus, dehiscence by a preformed convex lid. Capillitium and spores rust colored in mass, red by transmitted light. Capillitium tubular, expanding up to 5-9 mm, arranged spirally and completely filling the sporotheca, ornamented with 2-3 spiral bands and numerous long spines of 3-4 μm diam. (Fig. 11). Spores 9-10 μm diam., globose, spinose, under SEM the spine apices are flat and somewhat verrucose (Fig. 10).

Observations. *Metatrichia horrida* is reported only from Africa and America (Moreno *et al.*, 1997a). The American records are from the Mexican states of Baja California Sur (Moreno *et al.*, *op. cit.*) and Sinaloa (Lizárraga *et al.*, 1998).

Physarum globuliferum (Bull.) Pers.

Collections examined. SONORA: On dead wood and bark of *Juniperus* sp., in oak woodland and *Quercus-Juniperus-Pinus* forest. Yécora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2 µm
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15
5 µm
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5 µm

Figs. 12-16 ***Trichia affinis*** de Bary (AH 19595): 12-13. Spores. 14. Detail of capillitium ornamentation. 15-16. End of elaters.

Municipality, Rincón del Güérigo, km 251 Hermosillo to Yécora road, *leg.* M. Esqueda & E. Pérez-Silva, 16.VIII.1991, MEXU 24760, CESUES 151; duplicate as permanent slide in AH 19602.

Observations. The main characteristics of *Physarum globuliferum* are its stipitate sporocarps, gray peridium, calcareous, white or ochraceous stalk, short, conical columella, capillitium with small white nodes, and spores 7-8(-9) µm diam. It was previously reported from Mexico from the states of Chiapas (Emoto, 1933; Pérez-Moreno & Villarreal, 1988) and Veracruz (Welden *et al.*, 1979). Macbride (1922) and Braun & Keller (1976) recorded for Mexico without specifying the locality.

Stemonitis fusca Roth

Collections examined. SONORA: On dead wood, in tropical deciduous forest, oak woodland and pine forest. Alamos Municipality, Las Uvalamas ranch, *leg.* E. Pérez-Silva & M. Esqueda, 13.IX.1994, MEXU 24351, CESUES 1853. Border of Cuchujaqui river, *leg.* E. Pérez-Silva & M. Esqueda, 11.IX.1994, MEXU 24661, CESUES 1708. Yécora Municipality, Rincón del Güérigo, km 251 Hermosillo to Yécora road, *leg.* M. Esqueda & E. Pérez-Silva, 15.VIII.1991, MEXU 24356, CESUES 219. Mesa Grande, km 17 Yécora to Santa Rosa way, *leg.* E. Pérez-Silva & M. Esqueda, 15.VIII.1991, MEXU 24349, CESUES 200.

Observations. *Stemonitis fusca* is common in Mexico. It is distinguished by the spore ornamentation with a reticulum with small meshes.

Stemonitis splendens Rostaf.

Collections examined. SONORA: On living leaves of *Acacia* sp. and grasses, and on dead wood. Arizpe Municipality, urban border of Arizpe, *leg.* M. Esqueda & E. Pérez-Silva, 10.IX.1993, MEXU 24350, CESUES 1480. Yécora Municipality, urban border of Yécora, *leg.* M. A. Pestaño, 5.X.1995, MEXU 24363.

Observations. The main characters of *Stemonitis splendens* are the dark purplish brown spore-mass, a capillitial net with few main branches and the spore ornamentation as baculate under SEM.

Trichia affinis de Bary Figs. 12-16

Collections examined. SONORA: On dead wood, in pine-oak woodland. Yécora Municipality, Rincón del Sheriff, km 10 Yécora to Hermosillo road, *leg.* M. Esqueda & R. E.Villegas, 17.XI.1991, MEXU 24354, CESUES 632; duplicate as permanent slide in AH 19595.

Observations. The main microscopic characters of *Trichia affinis* are the 4-5 µm diam. elaters with smooth spiral bands and spores with broad-meshed complete reticulum, the meshes are decorated with a faint reticulation at center (Figs. 12-13). *T. persimilis* Karsten has a spinulose capillitium of 4-6 µm diam., and spores with a broken, patchy reticulum. In the Sonoran collections we have observed a decoration of short spines on the capillitium (Figs. 14-16) being similar to *T. persimilis*, but the spore ornamentation is that of *T. affinis*. Due probably to collections with an intermediate ornamentation of spore and capillitium, Farr (1958) and Martin & Alexopoulos (1969) considered these two taxa to represent one variable species. Others authors such as Nannenga-Bremekamp (1991) and Lado & Pando (1997) recognize three species within the *Trichia favoginea* complex. All the Sonoran collections are for the moment determined as *T. affinis*. This is a new record for Mexico.

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MONTAGNULACEAE, A NEW FAMILY IN THE PLEOSPORALES, AND LECTOTYPIFICATION OF DIDYMOSPHAERELLA

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ABSTRACT

The family Montagnulaceae is introduced in the Pleosporales related to the Cucurbitariaceae. In the Montagnulaceae ascomata are immersed in the substrate, often surrounded by abundant hyphae that may form an apical clypeus, with small-celled pseudoparenchymatous peridium, opening by a well developed papillate apex, asci cylindric or oblong and stipitate, and brown ascospores with walls often ornamented. Three genera are recognized: dictyosporous *Montagnula*, phragmosporous *Kalmusia*, and didymosporous *Didymosphaerella*. The latter genus is here lectotypified by *D. longipes*; the transfer is proposed of a second species, *Sphaeria opulenta*, to *Didymosphaerella*.

KEYWORDS: *Montagnula*, *Kalmusia*, *Didymosphaerella*, clypeate, papillate ascomatal apex

Revisionary studies on Loculoascomycetes revealed that certain genera are not well accommodated in the family Phaeosphaeriaceae. The relationships of these fungi are more closely scrutinized. The present contribution refers to the disposition of *Montagnula* Berl. 1896 and *Kalmusia* Niessl 1872. Barr (1987, 1992) had assigned both genera to the Phaeosphaeriaceae. Eriksson (1992, 1999) and Eriksson and Hawksworth (1998) included *Montagnula* in the Didymosphaeriaceae, but Hawksworth et al. (1995) assigned it to the Phaeosphaeriaceae. *Kalmusia* was assigned to the *Melanommataceae* (Eriksson 1992, Eriksson and Hawksworth 1998), or arranged under the Dothideales inc. sed. (Eriksson and Hawksworth 1991, Hawksworth et al. 1995, Eriksson 1999). The concept of the family Phaeosphaeriaceae has been both enlarged from the original sense (Barr 1979) and reduced by removal of several deviating genera (Barr 1987, Shoemaker and Babcock 1992). In Barr's (1992) revision the family was somewhat more homogeneous, but certain genera still posed problems.

These deviating taxa are those that were keyed in the final couplets of the key to genera (Barr 1992). My disposition (Barr 1987, 1990) of *Chaetoplea* (Sacc.) Clem. in Clem. & Shear 1931 has provoked disagreement. Eriksson and Hawksworth (1993, 1998) tentatively assigned the genus to the Leptosphaeriaceae; to me now it seems better arranged in the Massarinaceae, a family once again separated from the Lophiostomataceae (Barr, in prep.). Species in *Graphyllium* Clem. 1901 have much affinity with members of the Diademaceae and the genus is reassigned to that family, rather than the Hysteriaceae as Shoemaker and Babcock (1992) had proposed. Most taxa remaining in the Phaeosphaeriaceae form hyaline or lightly pigmented ascospores in clavate to oblong asci; the small to medium-sized ascomata are thin walled and the apical papilla is usually small and inconspicuous. Species in both *Montagnula* and *Kalmusia* share strongly pigmented ascospores in elongate asci; they tend to form medium to large, stout-walled ascomata with a well developed apical papilla. Another set of species that forms didymospores in similar asci and ascomata must also be considered here.

Following Crivelli's (1983) acceptance of dictyosporous *Montagnula* as a genus separate from *Pleospora* Rabenh., Leuchtmann (1984) added some phragmosporous species to *Montagnula*. Aptroot's (1995b) inclusion of didymosporous taxa so much weakens the generic concept that it would scarcely seem tenable. I postulate that three series of species, clearly separated upon ascospore septation, comprise three genera to be assigned to a separate family.

Montagnulaceae M.E. Barr, fam. nov.

Similis Cucurbitariaceae sed ascomatis in hyphis stromaticis ad clypeatis, apices papillatis, parieti dilatato in parte supera et ascosporis brunneioris et verruculosis vel foveolatis. Genus typicus: *Montagnula* Berl.

Ascomata globose, rarely somewhat subglobose, immersed to erumpent, medium to large sized, separate to gregarious or grouped, often surrounded by abundant hyphae that form an apical clypeus at times; apex a short or well developed, narrow or wide, terete papilla, thickened by closely adhering cells or hyphae at times; ostiole freqently periphysate when well developed; peridium two layered or often three layered in upper regions, outermost layer of dark or blackened small pseudoparenchymatous or scleroplectenchymatous cells, mid layer less pigmented, most visible toward apex, innermost layer of narrow, compressed rows of cells. Hamathecium of narrow cellular pseudoparaphyses, often in gel matrix. Asci cylindric or oblong to clavate and stipitate, basal to peripheral, (four-)eight-spored, bitunicate and fissitunicate; endotunica tending to be wide and ocular chamber often containing refractive rods. Ascospores clear brown, reddish brown or dark yellowish brown, often inequilateral to slightly curved, hemispores nearly equal and symmetric, or slightly unequal, one or several septate; wall firm, at times surrounded by gel coating, often verruculose or foveolate; usually one large globule per cell; uniseriate or biseriate in the ascus. Anamorphs where known or associated coelomycetous; conidiogenesis either holoblastic (*Sclerostagonospora)* or enteroblastic-phialidic (*Microsphaeropsis*, *Phoma*- or *Aposphaeria*-like).

Saprotrophic or hemibiotrophic, in large monocots especially members of Agavaceae, stout herbs, or branches of trees and shrubs. Type genus: *Montagnula* Berl.

This family is most closely related to members of the Cucurbitariaceae, which differ in the obtuse ascoma apex that contains a minute papillate ostiole, in the peridium tending to be widest in the lower rather than upper regions, and in thinner-walled, more pallid ascospores.

Montagnula Berl. 1896

Berlese (1896) created *Montagnula* for two dictyosporous species that he separated from *Pleospora*, stressing the presence of hyphal stromatic tisues over the ascomata and stipitate asci. He included *M. infernalis* (Niessl) Berl., the lectotype species (Clements and Shear 1931) and *M. gigantea* (Mont.) Berl., both on members of the Agavaceae. Wehmeyer (1957, 1961) opted to consider *Montagnula* as a subgenus of *Pleospora*, and accepted a few additional species. Crivelli (1983) reinstated *Montagnula* with two subgenera, subgenus *Montagnula* for species with dark brown ascospores on members of Agavaceae, and subgenus *Rubiginospora* Crivelli, typified by *M. spinosella* (Rehm) Crivelli, for species with red-brown ascospores on assorted substrates. He left separate *M. opaca* (Wegelin) Crivelli, with reddened ostioles and dark brown ascospores on members of the Poaceae. Such subgeneric separation does not seem valid, for reddish-brown pigmentation is frequent among agavaceous species in North America, as well as other species on various substrates.

The common species on Agavaceae in Europe and North America include *M. infernalis*, *M. thuemeniana* (Sacc.) Crivelli, and *M. phragmospora* (Durieu & Mont.) Crivelli (Crivelli 1983, Barr 1990, Checa and Barr 1999). Recent additions include the North American *M. dasylirionis* A.W. Ramaley & M.E. Barr, *M. mohavensis* A.W.Ramaley & M.E. Barr, and *M. yuccigena* A.W. Ramaley & M.E. Barr (Ramaley and Barr 1995). The species transferred by Crivelli (1983) into subgenus *Rubiginospora* include *M. gilletiana*

(Sacc.) Crivelli on *Cytisus*, and *M. spinosella* on various substrates, known in North America as well as Europe. Here also belong *M. opuntiae* (B.O. Dodge) Huhnd. (Huhndorf 1992), and *M. camarae* (M.T. Lucas) Checa on *Sarothamnus* in Portugal (Checa 1998), and a few other taxa.

Kalmusia Niessl 1872

The genus is typified by *K. ebuli* Niessl. Barr (1992) discussed the synonymy. *Dendropleella* Munk 1953 with *D. hirta* (Fr.) Munk is excluded as based on a coelomycete (Barr and Holm 1984). *Diapleella* Munk 1957 with *D. clivensis* (Berk. & Broome) Munk was recognized to be a possible synonym of *Kalmusia* (Munk 1957); it was arranged under Dothideales inc. sed. (Eriksson in Eriksson & Hawksworth 1991). Barr (1992) accepted four phragmosporous species in *Kalmusia*, each usually three-septate. These are *K. ebuli*, *K. clivensis* (Berk. & Broome) M.E. Barr, *K. coniothyrium* (Fuckel) Huhnd., and *K. utahensis* (Ellis & Everh.) Huhnd. & M.E. Barr.

Kalmusia sarothamni Feltgen 1901 is another valid taxon close to *K. clivensis*, described from *Cytisus scoparius* (L.) Link in Europe, evidently brought to North America with its host plant, and now recognized in British Columbia (e.g., Barr 7163 and other collections, DAOM). Other phragmosporous taxa to be added develop additional septa in the ascospores. Two were inserted in *Montagnula* by Leuchtmann (1984), *M. anthostomoides* (Rehm) Leuchtm. and *M. rhodophaea* (Bizz.) Leuchtm. Shoemaker and Babcock (1989) added *M. subsuperficialis* (Sacc. & Syd.) Shoem. & E.C. Babc., probably also a species of *Kalmusia*. A third species assigned to *Montagnula* by Leuchtmann (1984) is *M. hirtula* (Karst.) Leuchtm., which is the lectotype species of *Chaetomastia* (Sacc.) Berl. 1891. This latter genus is evidently a member of the Cucurbitariaceae, with a low blunt ascomatal apex and brown phragmospores whose terminal cells may be pallid.

Didymosphaerella Cooke 1889

Two of the didymosporous taxa that Aptroot (1995b) assigned to *Montagnula*, *M. longipes* (Trabut) Aptroot and *M. opulenta* (DeNot.) Aptroot (ss. str.), are related to the dictyosporous and phragmosporous species outlined above. I propose to utilize *Didymosphaerella* Cooke for such species and present the following arguments for its use.

Cooke (1889) in his serial 'Synopsis Pyrenomycetum' erected Gen. 7. *Didymosphaerella* with a three-word diagnosis: "Sporidia didyma, fuliginea." The sole references to the genus in Sylloge Fungorum appear to be in Volumes 9 (Saccardo 1891) and 15 (Mussat 1901), where *Didymosphaerella filicina* (as *felicina*) Cooke 1890 was reduced to synonymy under *Didymosphaeria pteridina* Sacc.,

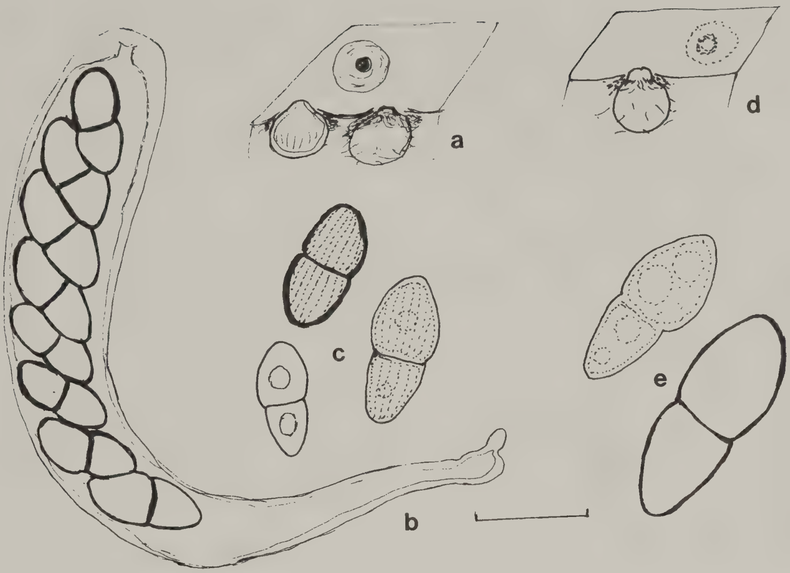

Fig. a-e. Species of *Didymosphaerella*. a-c, *D. longipes*. a, Habit. b, Ascus. c, Ascospores. (from J. Checa AH 24321). d, e, *D. opulenta*. d, Habit. e, Ascospores. (from J. Checa AH 23893). Standard line = 15 µm for ascus and ascospores. Habit sketches not to scale.

now considered to be a synonym of *D. futilis* (Berk. & Broome) Rehm (Aptroot 1995a). *Didymosphaerella* was not included in Clements and Shear's (1931) compilation where so many ascomycete genera were lectotypified. Müller and Arx (1962) [but not Arx and Müller (1975)] did cite *Didymosphaerella* as a synonym of *Didymosphaeria*, indicating that the type species was *Didymosphaerella filicina*. Aptroot (1995a) evidently followed their treatment. This taxon cannot typify *Didymosphaerella* Cooke 1889 because it was published a year later (Cooke 1890) and was not included in the protologue.

Among the species that Cooke (1889) assigned to *Didymosphaerella* is *D. longipes* (Trabut) Cooke. It appears to be a suitable choice to lectotypify the genus. The species develops in leaves of *Agave americana* L. It was described from Algeria and Dr. Checa was able to confirm that the type specimen was identical with her material from southern Spain (Checa and Barr 1999). The large, gregarious ascomata are clypeate, the hamathecium is composed of cellular pseudoparaphyses, the bitunicate asci are peripheral, oblong cylindric and stipitate. The ascospores are bright to dark brown, uniseptate and constricted at the septum, and measure 12-18 x 6-7.5(-10) µm. Their firm dark wall is ornamented by foveolae arranged to form longitudinal striae. The synonymy of the species is as follows.

Didymosphaerella longipes (Trabut) Cooke, Grevillea 18: 29. 1889. Figs. a-c

Didymosphaeria longipes Trabut in Sacc., Syll. Fung. Addit. 1-4: 411. 1886.

Microthelia longipes (Trabut) Kuntze, Rev. Gen. Pl. 3: 498. 1898.

Montagnula longipes (Trabut) Aptroot, Nova Hedwigia 60: 339. 1995.

A second species is accepted at this time. This taxon develops in cladodes of *Opuntia ficus-indica* (L.) Mill. It was described originally from Italy and Aptroot (1995b) cites specimens on this host from throughout the Mediterranean region, as well as from North America (USA: California, on *Opuntia tuna*, CUP). The fungus is similar in ascomata and asci to *D. longipes* but the ascospores are smooth walled and larger, 22-28 x 8-12 µm. Other names that Aptroot (1995b) synonymized under *Montagnula opulenta* are not accepted here. They apply to taxa of more northern distribution that develop in members of the Poaceae.

Didymosphaerella opulenta (DeNot.) Checa & M.E. Barr, comb. nov. Figs. d, e

Basionym: *Sphaeria opulenta* DeNot., Atti Accad. Sci. Torino, ser. 2, 3: 64. 1839.

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Didymosphaeria opulenta (DeNot.) Sacc., Syll. Fung. 1: 711. 1882.

Microthelia opulenta (DeNot.) Kuntze, Rev. Gen. Pl. 3: 498. 1898.

Montagnula opulenta (DeNot.) Aptroot, Nova Hedwigia 60: 340. 1995.

None of the other species that were assigned to *Didymosphaerella* by Cooke (1889) shows the features that set these two species apart. Aptroot (1995a, b) accounted for all but four of the 41 species recognized in the original publication by Cooke, those four being specimens that he could not locate. He dispersed the species of *Didymosphaerella* in various genera of unitunicate or bitunicate ascomycetes.

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NOTES ON HYPHOMYCETES. LXXIX. CONCERNING THE ACLADIUM-ALYSIDIUM-HAPLOTRICHUM COMPLEX; NOMENCLATURAL AND TAXONOMIC CONSIDERATIONS, WITH REDESCRIPTIONS OF RESPECTIVE TYPE SPECIES

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ABSTRACT

The generic name *Haplotrichum* is maintained for anamorphs of *Botryobasidium* on the basis of its having been sanctioned by Fries, although *Acladium*, which is considered a synonym, was published some fifteen years earlier. *Alysidium* is also regarded as being synonymous, in accordance with the genus-for-genus philosophy, although its type species differs somewhat morphologically from that of *Haplotrichum*. The species on which the three generic names are based are redescribed and illustrated in order to more clearly define the unified generic concept. A comprehensive description of the genus characteristics is also provided. The recombined binomial *Haplotrichum dubium* [≡ *Trichoderma dubium*] is adopted for the anamorph of *Botryobasidium aureum* because of the date priority of its basionym.

KEYWORDS: *Botryobasidium* anamorphs, generic concepts.

INTRODUCTION

During the course of deliberation as to taxonomic options available for the classification of two dematiaceous anamorphs collected on decorticated wood in South Africa (Partridge *et al.*, 2000) consideration was given to the generic name *Alysidium* Kunze in lieu of the fact that this has, in the not-too-distant past (Ellis, 1971; Sutton, 1973; Castañeda, 1986; Castañeda and Kendrick, 1990; 1991), been used to accommodate several morphologically similar entities. Upon evaluation, the availability of *Alysidium* for this purpose was, however, found to be untenable for several reasons, not least of which being the fact that it is now considered a synonym of *Haplotrichum* Link (Holubová-Jechová, 1980; Langer, 1994). Three genera, *Acladium* Link, as well as *Alysidium* and *Haplotrichum*, have, as their type species, anamorphs of *Botryobasidium* Donk, and, despite differing in some morphological respects, are now, given their common teleomorph connections, treated as a single taxonomic entity at the genus level. The respective taxa all produce hyaline to pale straw-colored conidia, quite unlike those of some of the species placed in *Alysidium*, particularly during the last two decades, which are darkly pigmented. Moreover, there are additional significant differences including colony characteristics in nature as well as substrate relationships.

With the placement of the anamorph currently known as *Alysidium resinae* (Fr.) M.B. Ellis in the genus *Acladium* [as *A. aterrimum* (Ehrenb.) S. Hughes] (Hughes, 1958) a measure of heterogeneity was introduced into the taxonomy, which has since been perpetuated and, more recently, extended. Both this species and others, such as *A. guttulatum* Castañeda, *A. minus* (Castañeda) Castañeda & Kendrick, and *A. pinarense* Castañeda & Kendrick, although being broadly similar in that they form chains of conidia acropetally, are quite different from species of *Haplotrichum* because, among other things, of their distinctly dematiaceous nature. This, quite apart from the fact that they have no teleomorph connection in *Botryobasidium*.

Haplotrichum was taken up for the anamorphs of *Botryobasidium* by Holubová-Jechová (1976) as a result of the conservation of the generic name *Oidium* for conidial states of *Erysiphe* R. Hedw. and related genera [*Taxon* 24:534, 1975]. Had the latter action not occurred the genus *Acrosporium* Nees [type species *A. monilioides* Nees, the anamorph of *Erysiphe graminis* DC.] would have been the valid taxonomic home for powdery mildew mitosporic stages. *Botryobasidium* asexual states had previously been classified in the genus *Oidium* Link, typified by *O. aureum* (Pers.) Link [≡ *Trichoderma aureum* Persoon], a name based on what is now known as *Sporotrichum aureum* Link [the type species of *Sporotrichum* Link] but which was misapplied by Link (1809). The actual fungus upon which Link (loc. cit.) based his initially monotypic genus *Oidium*, which was monographed by Linder (1942), who accepted thirty-one species within it, was what is now known as *Haplotrichum aureum* (Pers.) Holubová-Jechová [≡ *Acrosporium aureum* Persoon], an entirely different entity from *Sporotrichum aureum*. Interestingly, the binomial *Alysidium fulvum* Kunze, the type of *Alysidium*, is based upon the same anamorph, as is *Trichoderma dubium* Persoon [see Hughes, loc. cit., who examined authentic specimens in the Persoon collection housed at the Rijksherbarium, Leiden (L)], a name which predates *Acrosporium aureum* by some twenty-one years. Although Holubová-Jechová (1975) makes a statement to the effect that, to quote, *"T. dubium* is taxonomically identical with *O. aureum* in the sense of the species used by Link", in her subsequent publication (Holubová-Jechová, 1976) the basionym *Acrosporium aureum* is surprisingly adopted in preference to *T. dubium* in spite of the date priority of the latter. Since *T. dubium* is the first binomial ever applied to this anamorph, it is taken up herein as the basionym of a new combination in *Haplotrichum*.

When adopting the name *Haplotrichum* for *Botryobasidium* anamorphs, Holubová-Jechová (1976) took the position that, according to the starting-point provisions of the International Code of Botanical Nomenclature existing at that time, this took priority over the earlier *Acladium*. In a monographic revision of *Botryobasidium*, Langer (loc. cit.) also used the name *Haplotrichum* for its anamorphs. During the course of further consideration of the competing generic names, Partridge *et al.* (loc. cit.), given the enactment of changes in the ICBN made in 1981, suggested that the name *Acladium* should take precedence over *Haplotrichum*. Upon additional review, however, and taking into account the matter of sanctioning by either Elias Magnus Fries or Christiaan Hendrik Persoon, as a result of which names have protected status and are not affected by homonymous and synonymous names published earlier, it has been concluded that *Haplotrichum* should remain as the correct name for these entities. It was explicitly sanctioned by Fries in the Index of his *Systema mycologicum* 3, p. 93 (Gams, 1984), where it was emphasized in a footnote that the name had been previously overlooked. Fries, though printing *Haplotrichum* Eschw., which, with *Haplotrichum* Link, dates equally from 1824, in the same Roman letter in the Index, did not recognize this homonynous genus but placed the fungus upon which it is based [*Haplotrichum candidum* Eschweiler] in *Gliotrichum* Eschw., as *G. candidum* (Eschw.) Fr. [*Syst. mycol.* 3:378, 1832].

In a revision of species of *Haplotrichum* (Holubová-Jechová, 1980), in which no description of individual taxa was provided, twenty-two taxa were accepted, ten of which are known to be anamorphs of *Botryobasidium* subgenus *Brevibasidium* J. Erikss. In this circumscription, although the genus is not a large one, it was nevertheless felt necessary to subdivide it into two subgenera and a number of sections and subsections. The subgenera were defined by the presence or absence of clamp connections in the basal hyphae; that characterized by bearing clamps accommodating only one species. Sections, of which five were established, and subsections thereof, were based upon morphological variation of conidiophores and conidia, including such features as branching patterns, whether or not conidiogenous cells are discrete or integrated, presence or absence of conidial chains, and conidium shape. Allowing for the fact that there exists a considerable range of form within this complex, the present authors remain unconvinced of the need to burden the taxonomy with a plethora of segregating divisions.

In order to more clearly define the generic concept and more precisely delineate the generic limits of *Haplotrichum*, a treatment, including redescription and illustration, of the type species of its facultative synonyms *Acladium* and *Alysidium* [*Acladium conspersum* Link and *Alysidium fulvum*, respectively], as well as of *H. capitatum* (Link) Link, its type, is contained herein.

TAXONOMIC PART*

Haplotrichum Link, *apud* Willdenow, Linné *Species Plantarum*, edn IV, 6(1):52, 1824.

= *Acladium* Link, *Mag. Ges. naturf. Freunde*, Berlin, 3:11, 1809.

= *Alysidium* Kunze, *apud* Kunze and Schm., *Mykol. Hefte* 1:12, 1817.

= *Sporocephalium* Chev., *Flore Gén. Env. Paris* 1:60, 1826.

Colonies effuse, extensive, resupinate, predominantly hypochnoid, cottony or velvety, often farinaceous, loose or dense, and occasionally, in some species, becoming somewhat pulvinate, discrete or eventually confluent, variously colored, ranging from pale ochraceous to fulvous to tawny to rusty brown. Mycelium mostly superficial, made up of loosely intertwined, abundantly branched, often anastomosing, septate, broad, smooth, hyaline to sub-hyaline to very pale brown hyphae. Conidiophores semi-macronematous, mononematous, ascending, more or less erect, simple or branched, occasionally anastomosing, straight or, more often, somewhat flexuous, smooth, septate, fairly thick-walled, hyaline to very pale brown, or rarely dark rusty brown. Conidiogenous cells polyblastic, integrated, cylindrical, terminal or intercalary, or discrete as lateral, inflated, more or less ellipsoidal, vesiculose extensions, determinate, denticulate; denticles usually prominent, often numerous, short, relatively broad, cylindrical, or present as slight projections. Conidia acropleurogenous, arising holoblastically, solitary or in acropetally-produced, simple or branched chains of various lengths, dry, non-septate, mostly smooth, often moderately thick-walled, ellipsoidal to limoniform or almost spherical, hyaline to pale-yellowish to reddish-brown.

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* [Note: nomenclatural and taxonomic synonyms according to Hughes (loc. cit.), unless otherwise noted.]

Lectotype species: *Haplotrichum capitatum* (Link) Link.

Haplotrichum capitatum (Link) Link, *apud* Willdenow, Linné *Species Plantarum*, edn IV, 6(1):52, 1824 (Figure 1).

≡ *Acladium capitatum* Link, *Mag. Ges. naturf. Freunde*, Berlin, 3:11, 1809.

≡ *Sporocephalium capitatum* (Link) Chev., *Flore Gén. Env. Paris* 1:60, 1826.

≡ *Botrytis capitata* (Link) Duby, *Bot. Gallicum* 2:919, 1830.

= *Monilia candicans* Sacc., *Nuovo G. Bot. Ital.* 8:195, 1876.

≡ *Oidium candicans* (Sacc.) Linder, *Lloydia* 5:183, 1942.

= *Rhinotrichum niveum* Cooke & Massee, *apud* Cooke, *Grevillea* 16:10, 1887.

= *Physospora albida* Höhn., *Ann. Mycol.* 1:527, 1903 [*fide* Linder (1942)].

= *Nematogonium album* Bainier, *Bull. Soc. mycol. Fr.* 21:227, 1905 [*fide* Linder (1942)].

Teleomorph: *Botryobasidium candicans* J. Erikss., *Svensk Bot. Tidskr.* 52:6, 1958.

Colonies widely effuse, resupinate, hypochnoid, at first loose, cottony, whitish, later becoming denser, somewhat caespitose and pale- to cinnamon-buff in color. Mycelium mostly superficial, composed of branched, septate, interweaving, occasionally anastomosing, smooth, hyaline, 6 to 8 µm wide hyphae. Conidiophores semi-macronematous, mononematous, ascending, more or less erect, simple or sometimes branched, branches often oriented at a wide angle but eventually curving to assume a position roughly parallel to the main axis, mostly flexuous, smooth, septate, moderately thick-walled, denticulate, hyaline to very pale-yellowish, predominantly up to 150 um long, occasionally much longer, up to 500 µm, 7 to 9 µm wide at the base, 6 to 8 µm in the middle portion, attenuating to 5 to 6 µm wide distally. Conidiogenous cells polyblastic, integrated where terminal, or discrete as lateral branches which are frequently widely oriented relative to the stipe, sometimes creating a cruciate aspect, mostly club-shaped, determinate, bearing a number of distinct denticles at conidiation loci, up to 30 µm long, 8 µm wide at the base, up to 12 µm wide at their broadest circumference. Conidia acropleurogenous, holoblastic, in short, simple or branched chains, dry, unicellular, smooth, moderately thick-walled, broadly ellipsoidal and bearing a single apiculate papilla, or limoniform and bearing a papilla at each pole, or ramoconidium-like with two papillae in the distal portion, hyaline, mostly 11-13 X 8-10 µm in size, rarely up to 16 µm long.

On decorticated, decaying wood of deciduous trees; cosmopolitan.

Specimens examined: Nassau, Austria, K.W.G.L. Fuckel, autumn 1894 [*Funghi rhenani exsiccati* 124 (as 2512. *Rhinotrichum repens* Preuss.), L'Herbier Barbey-Boissier], BPI; on oak, Clarksville, New York, USA, C.H. Peck, August (as *Rhinotrichum niveum* Cooke & Massee), ex NYS, BPI.

This species was classified by Holubová-Jechová (1980) in her section *Haplotrichum*, subsection *Multidenticulata*.

Haplotrichum conspersum (Link) Hol.-Jech., *Česká Mykol.* 30:4, 1976 (Figure 2).

≡ *Acladium conspersum* Link, *Mag. Ges. naturf. Freunde*, Berlin, 3:11, 1809.

≡ *Sporotrichum conspersum* (Link) Fr., *Syst. Mycol.* 3:419, 1832.

≡ *Trichosporum conspersum* (Link) Fr., *Summa Veg. Scan.* 2:492, 1849.

≡ *Oidium conspersum* (Link) Linder, *Lloydia* 5:176, 1942.

[≡ *Haplotrichum conspersum* (Pers.) Hol.-Jech., *Česká Mykol.* 30:4, 1976 ≡ *Acladium conspersum* Persoon, *Mycol. Eur.* 1:28, 1822 (basionym authority miscitation)]

= *Sporotrichum oosporum* Ehrenb., Sylvae Myc. Berol., pp. 10, 22, 1818.

= *Sporotrichum fusco-album* Link, *Jahrb. Gewächsk.* 1:77, 1818.

= *Sporotrichum helvolum* Wallr., *Flora Crypt. German.* 2:280, 1833.

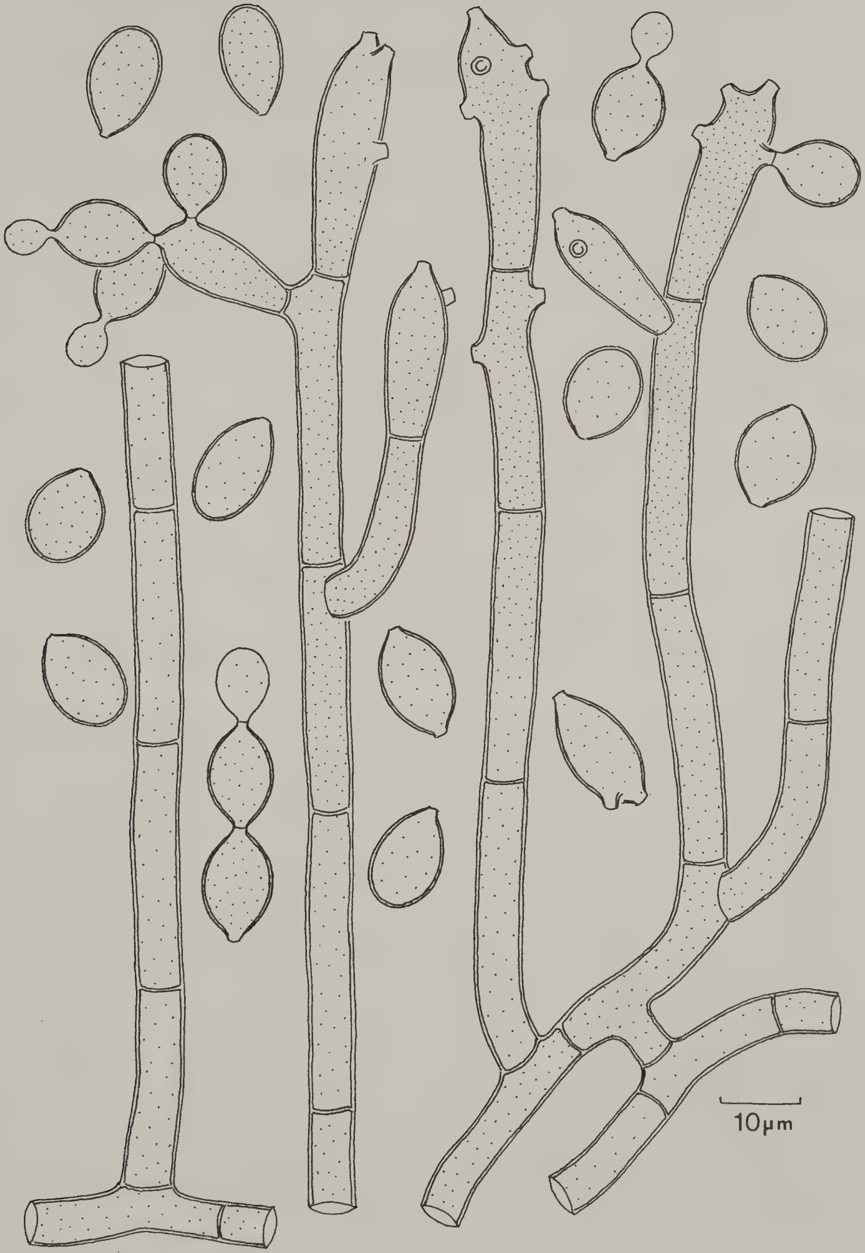

FIGURE 1. *Haplotrichum capitatum*. Conidiophores and conidia.

= *Rhinotrichum repens* Preuss, *apud* J. Sturm, Deutschl. Fl., 3, Bd 6(25-26):43, 1848.

= *Rhinotrichum sulfureum* Ell. & Everh., *Bull. Torrey Bot. Club* 11:18, 1884 [*fide* Linder (1942)].

= *Rhinocladium macrosporum* Karst., *Medd. Soc. F. F. Fennica* 16:31, 1888.

= *Rhinocladium fulvescens* Karst., Finlands Mögelsvampar., p. 29, 1892.

= *Rhinocladium olivaceum* Bres., *Fungi Tridentini* 2:106, 1900 [*fide* Linder (1942)].

= *Rhinotrichum bicolor* Sumstine, *Mycologia* 3:50, 1911 [*fide* Linder (1942)].

= *Rhinotrichum noblesiae* Sumstine, *Mycologia* 29:250, 1937.

Teleomorph: *Botryobasidium conspersum* J. Erikss., *Symb. bot. Ups.* 16:133, 1958.

Colonies effuse, often very extensive and spreading widely, at first cottony and creamy-white, but progressively becoming densely tomentose and pale snuffy-brown to leather-colored. Mycelium mostly superficial, composed of branched, septate, interweaving, rarely anastomosing, smooth, hyaline, 5 to 7.5 µm wide hyphae. Conidiophores semi-macronematous, mononematous, ascending, more or less erect, simple or often branched, straight or predominantly flexuous, smooth, septate, moderately thick-walled, evenly cylindrical, attenuating slightly to an obtuse apex, denticulate, hyaline to sub-hyaline or pale-yellowish, usually up to 250 µm long, occasionally longer, 5 to 8 µm wide. Conidiogenous cells polyblastic, integrated, determinate, terminal or intercalary, cylindrical, bearing numerous, conspicuous denticles at conidiation loci, varying somewhat in length, of the same width as the conidiophores or, when terminal, tapering to 3 to 4 µm wide. Conidia acropleurogenous, holoblastic, invariably solitary, dry, unicellular, smooth, moderately thick-walled, ellipsoidal, papillate at the base, hyaline, 13-22 X 9-12 µm.

On decorticated, decaying wood of deciduous trees; cosmopolitan.

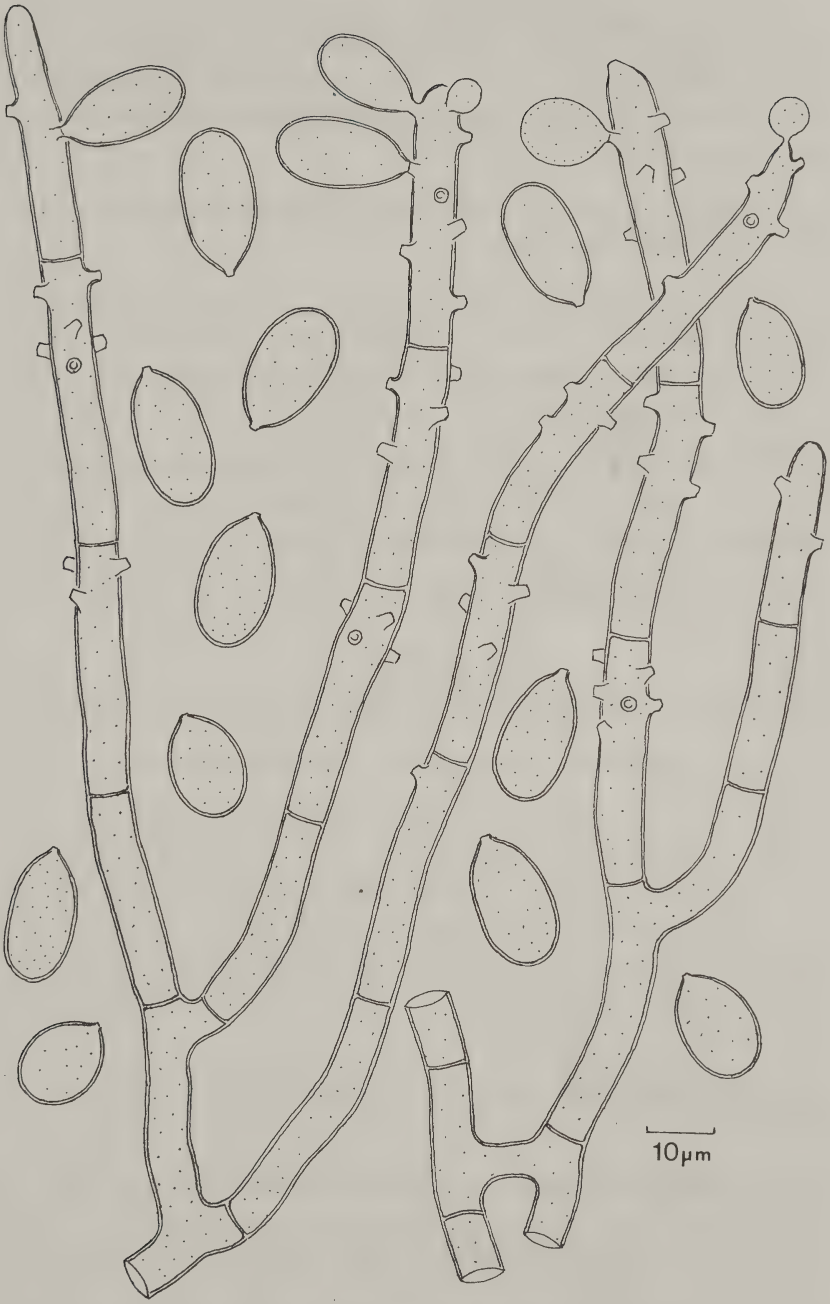

FIGURE 2. *Haplotrichum conspersum*. Conidiophores and conidia.

Specimens examined: on *Quercus* sp., Brookham Common, Surrey, United Kingdom, M.B. Ellis, 27 April 1947, IMI 14590, BPI; on *Fagus sylvatica*, Ranmore Common, Surrey, United Kingdom, S.J. Hughes, 25 May 1947, IMI 15528, BPI; on unidentified wood, Packenham, Ontario, Canada, R.J. Bandoni, 27 June 1962, UBC, BPI.

This species was classified by Holubová-Jechová (1980) in her section *Avesiculata*, subsection *Ellipsoidea*.

When reclassifying *Acladium conspersum* Link in the genus *Haplotrichum*, Holubová-Jechová (1976) miscited the authority for this binomial as Persoon [*Mycol. Eur.* 1:28, 1822]. In the latter publication, however, Persoon clearly ascribes the species to Link and, therefore, no homonym was created [W. Gams, *in lit.*]. In accordance with Article 33.4 of the ICBN, bibliographic errors of citation do not invalidate the publication of a new combination, hence Holubová-Jechová must remain as the author of the name *Haplotrichum conspersum* in spite of having erroneously cited its basionym as *Acladium conspersum* Pers. when making the transfer. An appropriate correction to this effect was made by Langer (loc. cit.) and is followed herein.

Haplotrichum dubium (Pers.) Baker & Partridge, comb. nov. (Figure 3).

≡ *Trichoderma dubium* Pers., Syn. Meth. Fung., p. 233, 1801.

≡ *Acladium dubium* (Pers.) S. Hughes, *Can. J. Bot.* 36:731, 1958.

[= *Oidium aureum* (Pers.) Link, *Mag. Ges. naturf. Freunde*, Berlin, 3:18, 1809 (misapplied name); = *Torula aurea* (Link) Corda, *apud* J. Sturm, Deutschl. Fl., 3, Bd 1(8):79, 1829 (*fide* Linder (1942)); = *Oospora aurea* (Link) Wallr., *Flora Crypt. German.* 2:183, 1833 (*fide* Linder (1942)).]

= *Alysidium fulvum* Kunze, *apud* Kunze and Schm., *Mykol. Hefte* 1:12, 1817.

≡ *Acrosporium fulvum* (Kunze) Pers., *Mycol. Europ.* 1:24, 1822.

≡ *Oidium fulvum* (Kunze) Link, Linné *Species Plantarum*, edn IV, 6(1):121, 1824.

≡ *Torula fulva* (Kunze) Corda, *apud* J. Sturm, Deutschl. Fl., 3, Bd 2(8):81, 1829.

≡ *Oospora fulva* (Kunze) Wallr., *Flora Crypt. German.* 2:183, 1833.

≡ *Oospora fulva* (Kunze) Sacc. & Vogl., *apud* Saccardo, *Syll. Fung.* 4:22, 1886.

= *Acrosporium aureum* Pers., *Mycol. Europ.* 1:25, 1822.

≡ *Haplotrichum aureum* (Pers.) Hol.-Jech., *Česká Mykol.* 30:3, 1976.

= *Monilia hesperidica* Saccardo, *Michelia* 1:86, 1877.

≡ *Oidium hesperidicum* (Sacc.) Linder, *Lloydia* 5:187, 1942.

? [= *Monilia harknessi* Peck, *N. Y. State Mus. Rep.* 34:49, 1881 (*fide* Linder (1942)).]

= *Monilia arctica* Karst., *Medd. Soc. F. F. Fennica* 18:24, 1888.

? [= *Monilia platensis* Speg., *An. Mus. Nac. Buenos Aires* 8:86, 1902 (*fide* Linder (1942)).]

= *Oidium murrilliae* Sumstine, *Mycologia* 5:49, 1913 (*fide* Linder (1942)).

[Note: in the list of synonyms given by Langer (loc. cit.), apparently derived directly from that published by Linder (loc. cit.), a number of author citations are incorrect.]

Teleomorph: *Botryobasidium aureum* Parm., *Eesti NSV Tead. Akad. Toim.*, biol. Ser., 14:220, 1965.

Colonies effuse, spreading, resupinate, at first loose, cottony, white to yellow, later becoming somewhat dense, powdery, darker, cinnamon-buff to rufus-brown in color. Mycelium mostly superficial, composed of branched, septate, loosely interweaving, frequently anastomosing, smooth, mostly hyaline, 1 to 3 µm wide hyphae. Conidiophores semi-macronematous, mononematous, loose to densely caespitose, ascending, more or less erect, simple or branched, branches often arcuate, occasionally assuming a somewhat parallel orientation relative to one another, often anastomosing, mostly flexuous, smooth, sparsely septate, fairly thick-walled, hyaline to pale-yellowish distally, up to 200 μm long, occasionally longer, 5 to 8 μm wide. Conidiogenous cells polyblastic, integrated or discrete, determinate, mostly terminal, occasionally intercalary, cylindrical to fusiform, bearing short, stubby denticles at conidiation loci, varying in length, of more or less the same width as the conidiophores, generally tapering distally. Conidia acropleurogenous, holoblastic, in short or medium-length, simple or branched chains, dry, unicellular, smooth, fairly thick-walled, predominantly limoniform and apiculate at one or both ends, or ramoconidia-like, with two denticles in the distal portion, pale-yellowish to somewhat yellowish-brown with age, 14-27 X 7-13 μm.

On decaying wood; Europe, North and South America.

Specimens examined: Tamsel, Berganlagen, Germany, P. Vogel, 1 December 1926, FH; Montello, Italy, P.A. Saccardo, autumn, 1874-1876, Mycotheca Veneta 1091, FH.

This species was classified by Holubová-Jechová (1980) in her section *Catenulata* which has no subsections.

The binomial *Oidium hesperidicum* is added to the nomenclator following examination of its type material. Although recognized by Linder (loc. cit.) as a separate entity, it differs very little morphologically from *H. dubium*. The conidiophores in Saccardo's specimens are more densely fasciculate than is perhaps usual in the species and the conidiogenous cells bear fewer denticles. These small differences are more likely a reflection of phenotypic plasticity than substantive genotypic discontinuity.

DISCUSSION

Although the morphological variation existing among anamorphs of *Botryobasidium* classified as species of *Haplotrichum* is considerable, its present conception seems preferable to their segregation in separate genera, as has historically been the case. Since something of a continuum occurs, quite apart from their close phylogenetic relatedness, a single genus makes sound taxonomic sense. It should be noted, however, that the anamorph of *B. croceum* Lentz remains classified in a genus of its own, namely *Allescheriella* Hennings. Its type and only species, *A. crocea* (Mont.) S. Hughes, extends the morphological divide among anamorphs of *Botryobasidium* and breaks down

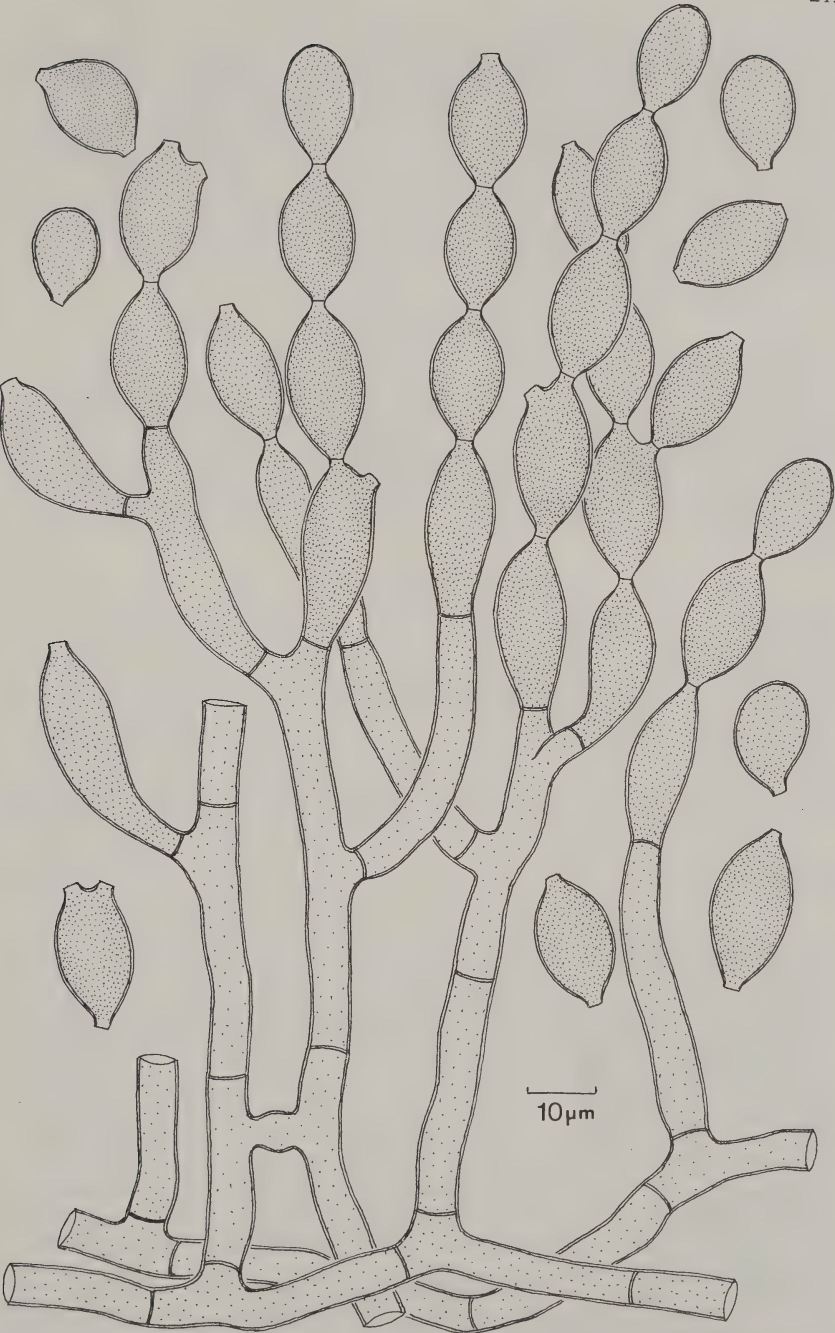

FIGURE 3. *Haplotrichum dubium*. Conidiophores and conidia.

any idealized genus-for-genus conceptualization. Although having similar colony and mycelium characteristics, this taxon differs in producing comparatively large, thick-walled, chlamydospore-like conidia. Linder (loc. cit.), interestingly, included this species in his broad concept of *Oidium*, together with anamorphs of *Botryobasidium* and the entities presently known as *Olpitrichum macrosporum* (Farlow) Sumstine (the type of *Olpitrichum* Atkinson) and *Olpitrichum tenellum* (Berk. & Curt.) Hol.-Jech. [see Holubová-Jechová (1974)].

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We have enjoyed the benefit of consultation with Drs. Walter Gams, Baarn, The Netherlands, and Keith A. Seifert, Ottawa, Canada, on matters nomenclatural. We are grateful for their advice in unraveling some of the questions surrounding the meticulosities of name usage. We thank Drs. Amy Y. Rossman [BPI] and Donald H. Pfister [FH] for the loan of specimens on which this study was based. Dr. J. Leland Crane provided a pre-publication manuscript review, which we greatly appreciate.

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RESTUDY OF SOME TYPE SPECIMES OF TREMELLA (I)

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The type specimens of *Tremella australiensis, T. brasiliensis, T. coalescens, T. microspora,* as well as *T. samoensis* were restudied. Detailed illustrations and descriptions are presented and the taxonomic status of the species is discussed. *Tremella australiensis* is proposed to be synonym of *T. spectabilis*, while *T. samoensis* is considered synonym of *T. cinnabarina*. Mycoparasitism of *T. microspora* on *Stereum*-like fungi is described for the first time.

Key Words: *Tremella australiensis, T. brasiliensis, T. microspora, T. samoensis, T. cinnabarina, T. spectabilis.*

Introduction

The genus *Tremella* was created by Dillenius in 1741 (Dillenius, 1741) and, since then, has been investigated by many mycologists. In spite of numerous studies, the taxonomy of *Tremella* is still not clear since most of the type material has been lost and the original descriptions and illustrations of various taxa are obscure or confusing. Moreover, the descriptions of hymenium and subhymenium, inner parts of basidiocarps, sterile surface close to the substrate, as well as the characterization of the conidial stages were not provided for most species. Finally, ambiguous terminology created, in some cases, additional difficulties.

Members of the genus *Tremella* have the largest and the most heterogeneous basidiocarps in the family Tremellaceae and comprise allegedly mycoparasitic species growing on the hymenium of Aphyllophorales, in basidiocarps of Dacrymycetales, on perithecia and/or stromata of Ascomycetes, as well as on lichens. A description of *Tremella* Pers. *sensu lato* is: jelly-like basidiocarps, soft to firm-gelatinous when moist, tremulous, pulvinate or cerebriform to foliose or lobed, flat or horny when dry; basidia globose to ovoid or pyriform to capitate or clavate, longitudinally and/or obliquely cruciate-septate; sterigmata cylindrical, with or without swollen apex; basidiospores subglobose to oval, germinating by budding or repetition, occasionally by germ tubes;

generally growing on dead wood, sometimes associated with other fungi (Bandoni, 1987 & 1995).

This study aims to investigate some type specimens of *Tremella* collected and described by Lloyd and Olive, in order to propose an updated species delimitation and also to evaluate their respective taxonomic status. Special attention was given to the characteristics of the conidial stage, since measurements of basidia and spores alone could not provide enough information for species identification. Possible associations with other fungi were examined in order to detect symbiotic, parasitic or saprophytic strategies.

Materials and Methods

After collection, a portion of the material was fixed in 2% glutaraldehyde and kept at 4℃. Another portion was immediately dried. Material preserved in both ways was subsequently used for light microscopy. Illustrations were prepared using a Zeiss Lab16 light microscope with phase contrast. For analyzing hyphal texture Phloxin b or Cotton blue was used as stain after application of potassium hydroxide (5 %).

Taxonomy

***Tremella australiensis* Lloyd 1913** (Figs. 1-4)
Myc. Writ. 4: L. 45, p.7.

Basidiocarps fleshy-gelatinous, convolute, foliose, deep yellow (according to the note of collector, G. H. Adock, enclosed in the package of the type material). Dry material big and thick, lobes caespitose, yellowish to rust-colored. Basidiocarps probably larger than 10 cm ø, as estimated from the size of dry material.

Basidia mostly ±subglobose when young, oval to pyriform and clavate when mature, (12-) 14-23 (-26) x (10-) 12-15 (-20) µm [Q*=(0.80-)0.86-1.75 (-2.36)] (not including stalks), often two basidia in chains; with or without stalks; stalks up to 20 µm in length, 2-3 µm ø; septa of mature basidia mostly irregular, especially those of oval to clavate basidia, obliquely, longitudinally or irregularly septate, particularly those of oval to clavate basidia with 3-septa; mostly 4-spored, rarely 2-spored; sterigmata up to 60 µm, 2-3.5 µm ø, apically swollen up to 10 µm ø. Spores broadly ellipsoid to ellipsoid, rarely subglobose or oval, 8-11 x 6.5-8 (-10) µm [Q=(1.10-) 1.20-1.43(-1.54)], smooth, hyaline, germinating by budding or repetition, sometimes also by germ tubes. Conidia monokaryotic, mostly 4-7 x 3-4 µm [Q=1.14-1.75], thin-walled, hyaline, smooth, budding from conidiogenous cells; conidiogenous cells variable, mostly vase-like, 6-24 x 4-12 µm, producing conidia almost from any hyphae in young basidiocarps. Swollen cells absent or not clearly seen; in young basidiocarps some swollen cells produce conidia by budding. Hyphidia not seen. Hyphae thin-walled or slightly thick-walled, gelatinous, 2-4 µm ø, clamped, closely interwoven in young basidiocarps, mostly swollen at the septa, but rarely swollen in mature basidiocarps; hymenia amphigenous. Host hyphae clampless, mostly irregularly swollen, sometimes moniliform, up 17 µm ø. Haustoria abundant, clamped, haustorial hyphae mostly single, rarely branched. Growing on dead wood, host fungus is a Homobasidiomycete without clamps. Type locality in Australia, Victoria. Distribution known only in Australia. Holotype (BPI

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* Q value = length / breadth ratio (Bas, 1969).

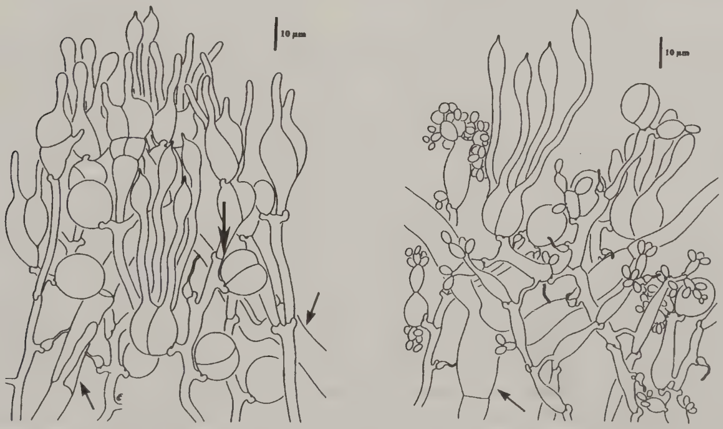
702691) specimen deposited in USDA.

Like in *Tremella microspora* Lloyd, in *T. australiensis* all cellular structures of the basidiocarp are growing together with host hyphae. The shapes of mature basidia are variable and frequently young basidia grow directly from older basidia, as in *Sirobasidium* (Bandoni, 1984). However, *Sirobasidium* species produce basidiospores on very short sterigmata, while *T. australiensis* has long sterigmata. *Tremella australiensis* might be interpreted as an intermediate between *Sirobasidium* and *Tremella*, thus suggesting that *Sirobasidium* has been derived from *Tremella* species with chained basidia (Olive, 1958) or that *Tremella* evolved from *Sirobasidium* (Möller, 1895; Bandoni, 1957 & 1984).

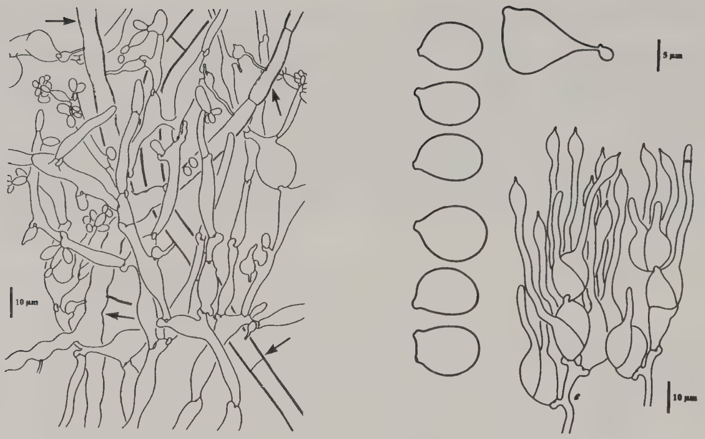
The conidial structures are similar to those of *T. aurantia*, but differ in the conidiogenous cells. Roberts (1995) synonymized *T. australiensis* with *T. aurantia*. However, our studies indicate that they are two distinct taxa differing in their basidial shape and sizes, conidiogenous cells, torulose hyphae, as well as in the basidiospores.

Tremella steidleri (Bres.) Bourdot & Galzin (1928) was erected from *T. encephala* (Fr.) Bref. var. *steidleri* Bres. (1908) and is very close to *T. australiensis* because basidia often have irregular septa and conidia are borne on the extremities of branches or torulose hyphae. Bandoni and Oberwinkler (1983) restudied the type material of *T. spectabilis* and we studied the type of *T. australiensis*. Both species proved to have similar structures and have identical basidia and basidiospores. Therefore, *T. australiensis* is proposed to be synonym of *T. spectabilis*.

Bandoni (1958) noted a similarity between *T. australiensis* and *T. frondosa*, but actually *T. australiensis* is a parasite in *Stereum*-like fungi. They are therefore two distinct taxa.



Figs. 1-2. *Tremella australiensis* BPI 702691 (type). 1. Part of hymenium at the surface of a mature basidiocarp with basidia in different developmental stages, three haustoria attaching to host hyphae (arrows). Note that basidia are frequently in chains. 2. Part of the hymenium at the surface of a young basidiocarp with two mature basidia, different types of conidiogenous cells producing numerous conidia by budding, and haustoria attaching to host hypha (arrow). Note that conidiogenous cells and basidia derive from the same generative hyphae.



Figs. 3-4. *Tremella australiensis* BPI 702691 (type). 3. Structure of the inner part of young basidiocarp. Note that haustoria are attaching to the host hyphae (arrows) and that conidia are produced from torulose hyphae. 4. Basidia in chains and basidiospores. Note that sterigmata are apically swollen.

***Tremella brasiliensis* (Möller) Lloyd 1922** (Figs. 5-6)
Möller, Protobas. 100. 1895 (basionym); Lloyd, Myc. Notes p. 1152, fig. 2239.
=*Tremella lutescens* Pers.: Fr. f. *brasiliensis* Möller, Protobas. 100. 1895.

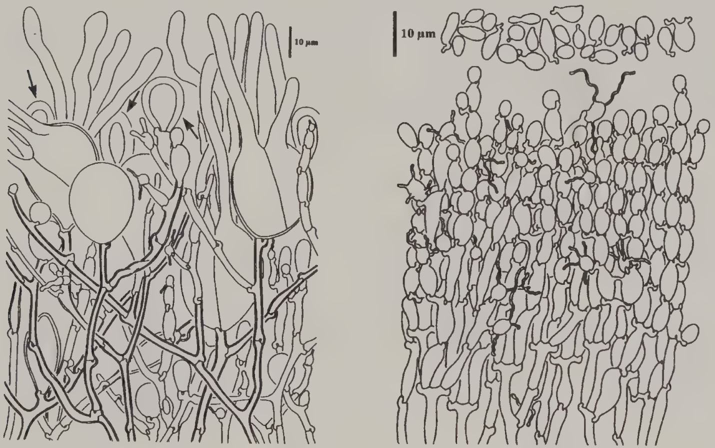
Basidiocarps erupt from the cortex of dead branches, at first cerebriform, then becoming foliose, the lobes gelatinous thick, pale yellow when dry. The type material is composed of several pieces, some of them are pale yellow, but others are brown. The brown pieces are probably from the basal part of the basidiocarps, close to the substrate.

Basidia of two types: type I, subglobose to broadly ellipsoid; (27-)30-42 x (23-) 26-32(-35) µm [Q =(1.00-)1.07-1.25 (-1.35)]; type II, pyriform, 35-40 x 24-33 µm [Q=1.21-1.50] (measurements not including stalks); stalks 2-5(-7) µm in length, 2-3 µm ø; thin- to thick-walled, longitudinally or obliquely cruciate-septate, 4-spored; sterigma up to 115 µm in length, 3-5 µm ø, apically swollen up to 8 µm ø. Spores ± globose, rarely subglobose, (11-)13-20 x (12-)13-21 µm [Q=(0.88-) 0.92-1.04(-1.13)], sometimes broader than long, hyaline, smooth, germinating by budding or repetition. Conidia mostly ellipsoid to fusiform, sometimes subglobose to globose, 4-7(-8) x 3.5-4.5 µm [Q=(1.0-)1.13-2.0(-2.29)], hyaline, smooth, clamped, dikaryotic. Vesicles variable in shape, ellipsoid to cylindrical, occasionally clavate, mostly 17-34 x 12-22 µm [Q=1.18-2.54], thick-walled, only seen in the subhymenium and hymenium. Swollen cells not seen. Hyphidia smooth, hyaline, 2-3(-4) µm ø, thin- to slightly thick-walled, sometimes bearing haustoria. Hyphae clamped, thin- or slightly thick-walled, gelatinous, 2-4 µm ø, smooth, hyaline. Haustoria abundant, mostly 5-8 x 3-5 µm [Q=1.11-1.78], clamped, branched. Growing on the cortex of dead branches. Type locality in Brazil, Blumenau. Distribution known only in Brazil, Panama. Neotype: BPI 718395 (selected by Bandoni, 1957) deposited in USDA.

Möller (1895) considered that *T. brasiliensis* is a variety of *T. lutescens*, but Lloyd (1922) pointed out that, although they have the same color and the same basidia and spores, their habits and shape are different. The holotype of *Tremella brasiliensis* was lost and Möller (1895) gave no clear and detailed description. Bandoni (1957) suggested that *Rick* 38792 (=BPI 718395) should be designated as the neotype for the species.

However Lowy (1971) argued that *Rick* 444 was in excellent condition and would serve better as the neotype. We do not agree with Lowy because conidia are lacking in this specimen and, for taxonomic studies of *Tremella*, this stage is frequently more important than the basidial stage. We agree with Bandoni, that specimen *Rick* 38792 (=BPI 718395) is more useful for a neotype than *Rick* 444. Although Bandoni and Lowy studied this species excellently using two different specimens of Lloyd, they did not conduct detailed studies on conidial morphology. Furthermore, some important structures, for example, dikaryotic conidia and vesicles, were not mentioned by them.

The hymenial basidia are similar to those of *T. mesenterica*. However, the basidia of *T. brasiliensis* are bigger, probably the largest in the genus. The morphology of dikaryotic conidia differs from those of *T. mesenterica*. The conidial stage of *Tremella mesenterica* is probably also variable and is presumably useful for classification.



Figs. 5-6. *Tremella brasiliensis* BPI 718395 (neotype). 5. Part of the hymenial structure on the surface of a mature basidiocarp. Arrows indicate vesicles. 6. Part of the hymenium close to the substrate with conidiogenous cells producing clamped conidia in chains, branched haustorial hyphae and detached conidia variable in shape.

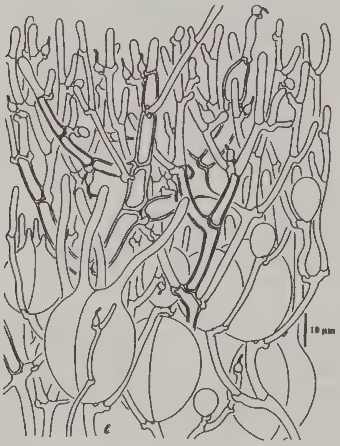
***Tremella coalescens* Olive 1951** (Fig. 7)
Mycologia 43: 678.

Basidiocarps growing on corticate oak branches, blackish brown to cinnamon-brown, sessile and pulvinate, discoid, or substipitate, with short tapered base to a narrow stalk, many individual fruiting bodies expanding and coalescing into conspicuous, gyrose-folded, up to 2-3 cm ø, soft, gelatinous; drying to a black crust (according to Olive, 1951, and Bandoni, 1957).

Basidia of two types: type I, big sized, ±globose, ellipsoid to oval, (24-) 26-37 (-40) x 24-29 µm [Q=0.83-1.42(-1.60)], longitudinally or obliquely cruciate-septate, mostly 4-spored, occasionally 2-spored; sterigmata up to 100 µm in length, 3-4 µm ø, slightly swollen apically; type II, small sized, ±globose, ellipsoid to oval, 19-25(-28) x 16-21 µm [Q=0.95-1.31(-1.56)], longitudinally or obliquely septate, 4-spored; sterigmata up to 85 µm in length, 2-3 µm ø, slightly swollen apically. Spores ±globose, subglobose, to broadly ellipsoid, (10-)13-18.5 x (11-)12-16.5 µm, thin walled, hyaline, smooth, germinating by repetition or budding, or sometimes by germ tubes. Conidia absent.

Vesicles absent. Swollen cells absent. Hyphidia thin- or thick-walled in the hymenium, hyaline, smooth, mostly shorter than 30 µm in length; when thick-walled, 3-5(-10) µm ø; if thin-walled, mostly (1-)1.5-3.0 µm ø. Hyphae clamped, thin- or slightly thick-walled, gelatinous, mostly 2-3 µm ø; hymenia amphigenous. Haustoria abundant, mostly globose to subglobose; haustorial hyphae short, rarely branched. Growth on corticate oak branches. Type locality in the U. S. A., Louisiana, Baton Rouge. Distribution in the U. S. A. and Canada. Holotype (LA 129) specimen deposited in the New York Botanical Garden.

During the study of the type material, we thought it was a mixture of two different species because of the quite different sizes of the basidia from different basidiocarps. However, the similar structures, especially the abundant hyphidia in the hymenium, suggest that they belong to one species. The original measurement of basidia was 24.5-33 x 19-26 µm. This fits more or less with our measurements, (24-) 26-37(-40) x 24-29 µm, but basidia of some other basidiocarps in the package of the type material measure 19-25(-28) x 16-21 µm. This was not included in Olive's publication. Therefore, the correct size of basidia of *T. coalescens* should be redefined to be 19-37(-40) x 16-29 µm. Unfortunately, basidiospores are not abundant in the material. Only few basidiospores could be detected in our preparations.



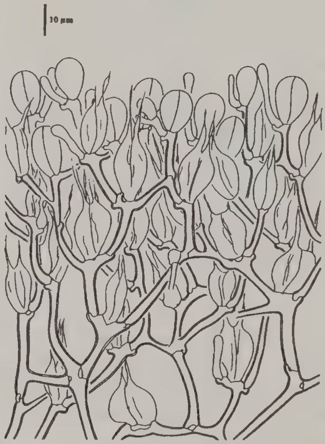


Fig. 7. *Tremella coalescens* La 129 (type). Basidiospores and part of the hymenial structure on the surface of a mature basidiocarp with basidia of different developmental stages, abundant hyphidia, and haustoria. Note that hyphidia are thin- to thick-walled.
Fig. 8. *Tremella samoensis* BPI 702354. Part of the hymenium with basidia of different developmental stages, subhymenial hyphae with frequent anastomoses.

***Tremella cinnabarina* (Mont.) Pat. 1900** (Fig. 8)
Myc. Notes 60: 875, fig. 1495.
≡*Naematelia cinnabarina* Mont. Ann. Sci. Nat. Bot. er. 3, 20: 120. 1848.
≡*Tremella samoensis* Lloyd 1919

Basidiocarps foliose, firm gelatinous, brownish orange when dry, pale yellow when soaked in water (fresh material probably yellow).

Basidia: broadly ellipsoid to oval, 12-18 x 8-12(-14) µm [Q=1.13-1.54], frequently longitudinally or occasionally obliquely cruciate-septate, 2- or 4-spored; sterigmata up to 30 µm in length, 2-3 µm ø, slightly swollen apically. Spores broadly ellipsoid to ellipsoid, 6-8 x 4-6 µm, germinating by repetition or budding (according to Bandoni, 1957). Conidia absent. Vesicles absent. Swollen cells absent. Hyphae clamped, smooth, hyaline, 2-4 µm ø, thick-walled, gelatinous; hyphae bearing basidia terminally, new hyphae proliferating from basidial clamps, often anastomosing; hymenia amphigenous. Haustoria rare. Growing on the stromata of ascomyetaceous fungi on decayed wood of *Artemisia vulgaris*. Type locality in Tahiti. Distribution in Tahiti, Samoa, and the Philippines. Holotype (BPI 702354, labeled *Tremella samoensis*) specimen deposited in USDA.

Lloyd had a tiny fragment of *Naematelia cinnabarina* that came from Montagne's specimen. Lloyd decided that his species, *T. samoensis,* was synonymous of the above (Lloyd, 1922). Kobayasi (1939) described the new species *T. flammea*, after collecting a red tremelloid fungus in New Guinea. He decided that his species was synonymous with *T. cinnabarina* (Mont.) Pat. (Kobayasi, 1974). The type of *T. samoensis* in Lloyd's collection resembles *T. cinnabarina.* According to Bandoni's study (1957, Plate I, fig. 4), the hyphae bear basidia terminally that proliferate laterally (fig. 8). Bandoni (1957) studied the type material of *T. samoensis* and a fragment of the type of *Naematelia cinnabarina* (=*T. cinnabarina*) from Lloyd's collections. He found no significant differences between the two. Therefore, *T. samoensis* was considered synonym of *T. cinnabarina* by Bandoni (1957). Our results from the investigation of the type of *T. cinnabarina* are in agreement with Bandoni's view.

The type material of *T. samoensis* is very fragmented, with pieces of thin substrate subtending the basidiocarps of *Tremella*. Stromata of ascomycetous fungi associated with *T. samoensis* can be detected on the inner surface of the substrate. Basidiospores were difficult to find. However, based on the hymenial structure, it can be predicted that *T. samoensis* belongs to the Fuciformis group (Chen, 1998). Important characters of the hymenial structure of *T. samoensis* are 1) new hyphae that proliferate directly from basidial clamps, then producing new basidia, 2) hyphal anastomoses forming very often a very stout structure, 3) absence of hyphidia and 4) association with ascomycetous fungi, probably *Hypoxylon* spp. Moreover, there is evidence of a phylogenetic relationship with the Fuciformis group from a morphological point of view (Chen, 1998).

***Tremella microspora* Lloyd 1920** (Figs. 9-12)

Myc. Notes 64: 991, fig. 1769.

Basidiocarps applanate-foliose, thin, soft; with lobes of 2-5 cm ø or more, about 1 mm in thickness, firm-gelatinous, avellaneous, parts reddish cream when fresh, light brown to brown when dry, avellaneous when soaked. (Referring to description of Lloyd (1920) and Bandoni (1957)).

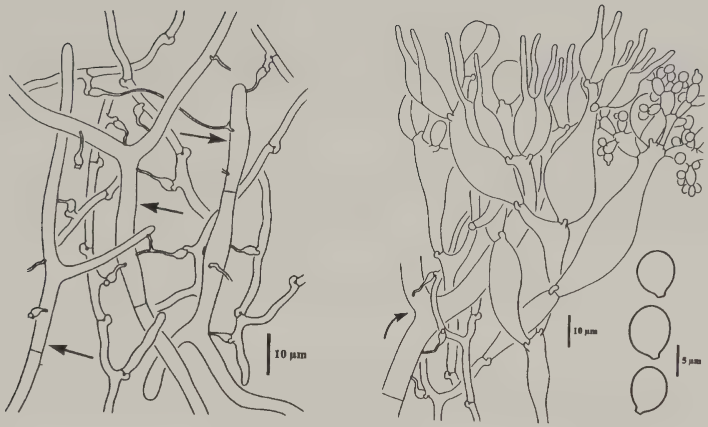
Basidia ±subglobose, pyriform to capitate, (10-)13-18(-20) x (8-)9-13(-15) µm [Q=(0.83-)1.00-2.00(-2.63)] (not including stalks); stalks mostly 2-4 µm long, up to 12 µm long; swollen cells normally bearing 2- to 4-, rarely 1-basidia, generally becoming longitudinally to obliquely, sometimes irregularly cruciate-septate, mostly 4-, rarely 2-spored; occasionally basidia produce conidia (fig. 12); sterigmata up to 55 µm long, sometimes very short, less than 10 µm, 1.5-3 µm ø, apically swollen up to 5 µm. Spores subglobose to broadly ellipsoid, 6-7.5(-9) x 5-6.5(-7.5) µm [Q=1.08-1.27], hyaline, smooth, germinating by budding or repetition. Conidia mostly spherical, rarely oval to fusiform, (2-)3-5(-6) x (2-)3-4.5 µm [Q=1.0-1.67(-2.0)], hyaline, smooth; conidiogenous cells deriving from sterile basidia or swollen cells, clampless, pocket-like in the hymenium. Vesicles absent. Swollen cells absent. Hyphidia not seen. Hyphae clamped, hyaline, 1.5-5(-8) µm ø (not including the swollen cells in subhymenium), forming a compact amphigenous surface in the hymenium; swollen cells frequent in the subhymenium, size and shape variable, cylindrical, clavate, fusiform, or subglobose, mostly 15-42 x 13-24 µm, with or without stalks, bearing apically 1-4 basidia, sometimes bearing a new swollen cell, or producing directly chained- and branched-conidia. Host hyphae growing into the inner part and up to the subhymenium of the parasite. Haustoria numerous, clamped, haustorial hyphae rarely branched. Growing on dead wood. Type locality in Stellenbosch, University of South Africa. Distribution in South Africa. Holotype specimen (BPI 702328) deposited in USDA.

The clampless hyphae of the host can be observed in the whole basidiocarp of *T. microspora*. Lloyd (1920) and Bandoni (1957) gave no description of the host at all. However, comparing the distribution of host hyphae in the basidiocarp, *Tremella microspora* is definitely similar to *T. aurantia, T. encephala* and *T. australiensis*. Lloyd (1920) once mistook *T. microspora* for *Auricularia*. He apparently thought the conidia were basidiospores. The big-sized and clampless host hyphae look like those of *Stereum*, but this could not be confirmed. It might be the same situation as in *Syzygospora nivalis* C.-J. Chen, F. Oberwinkler & Z.-C. Chen (Chen *et al.*, 1998), where host hyphae and parasite are mixed, but no fertile host basidiocarp could be found.

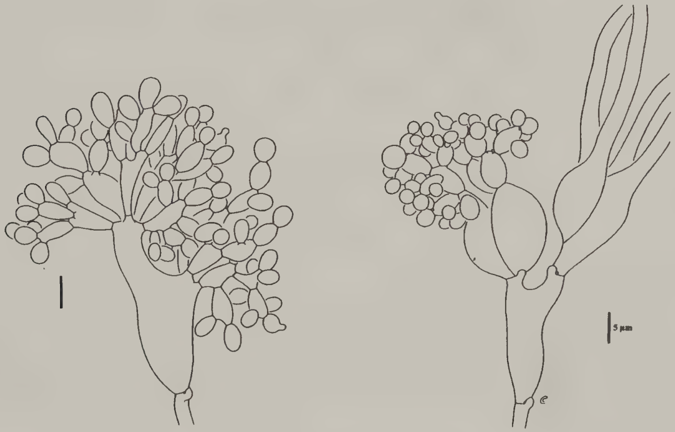
The conidial stage is rarely investigated in the genus *Tremella*. In contrast to *T. aurantia* and *T. australiensis*, the conidia of *T. microspora* are born from swollen cells, or occasionally from basidia. The conidial structure looks like a pocket, and is very stout. Therefore, it is difficult to find them with light microscopy. The stout conidial structures occur presumably in *T. spectabilis* (Bandoni & Oberwinkler, 1983) and *T. boraborensis* (Olive, 1958), according to the authors' descriptions.

Tremella boraborensis, collected in Tahiti, was considered to be related to *T. microspora* (Olive, 1958). Olive's description (1958) "large subhymenial hyphae more frequently lacking clamp connection" (fig. 22, i. & j.) could be possibly host hyphae, most likely those of a *Stereum* or a similar fungus, mixed in the subhymenium of *Tremella* basidiocarps. "Small bulbous structures with slender, simple or branched filament often associated with clamp connections" are typical of haustoria shown in Olive's (1958) illustrations (fig. 22, k. & l). Those characters are similar to these of the Aurantia group, and the basidia [14.5-29.5(-35) x 9-12.5 µm (including stalks)] and basidiospores (8-10.5 x 5-8 µm) are very close to *T. microspora*. In Olive's collection (T240), "a large number of conidia were present but their origin could not be determined" probably because the pocket-like conidial structures that are very hard. Therefore it is difficult to make a preparation for microscopy. *Tremella boraborensis* seems very similar to *T. microspora*, if not conspecific, at least closely related. However, type materials have to be restudied before decisions concerning their classification are made.

Tremella compacta was studied by Bandoni (1957 & 1958) from Lloyd's collections in Brazil. It appears to be similar to *T. microspora*. Bandoni agreed, that the specimen determined by Lloyd fits to the description by Möller. Bandoni described "hyphae scattered throughout the interior and sometimes penetrating the hymenium and then resembling gloeocystidia" which are obviously host hyphae. "The fertile hyphae erect, often with moniliform areas of vesiculose cells up to 30 µm in diameter, these often terminated by one or two basidia, or basidia borne terminally or alternately on slender hyphae" are similar to the type of *T. microspora* (figs. 9-10). The measurements of basidia and basidiospores are comparable in both taxa. In addition, *T. compacta* sensu Lowy (1971) collected in Brazil is also considered to belong to the Aurantia group based on the published graph (fig. 26A). Lowy (1971) provided no information concerning the host. The type locality of *T. compacta* described by Möller (1895) was in Brazil. It is therefore possible that *Tremella microspora* is conspecific with *T. compacta*. However, type material of *T. compacta* should be restudied more carefully before any decisions are made.



Figs. 9-10. *Tremella microspora* BPI 702328 (type). 9. Structure of the inner part of the basidiocarp with clamped hyphae bearing many haustoria attaching to the host hyphae (arrows). 10. Three basidiospores and part of the hymenium with basidia in different developmental stages. One basidium and some conidiogenous cells producing numerous conidia by budding are derived from the same hypha. Three haustoria are attached to the host hyphae (arrow). Note that the cells under basidia are swollen and frequently produce two basidia.



Figs. 11-12. *Tremella microspora* BPI 702328 (type). 11. Conidiogenous cells producing numerous monokaryotic conidia. 12. Two basidia growing from a swollen cell. Conidiogenous cells are growing from the septate basidium on the left side and are producing numerous conidia.

Acknowledgements

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PARMELIOID LICHEN GENERA AND SPECIES IN TAIWAN

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ABSTRACT

A total of 19 genera and 97 species represent the Taiwanese taxa of *Parmelia* and related genera exclusive of the essentially cetrarioid groups in the Parmeliaceae. Thirty four species are reported herewith as new to Taiwan: *Bulbothrix tabacina* (Mont. & Bosch) Hale, *Canomaculina leucosemotheta* (Hue) Elix, *Canoparmelia texana* (Tuck.) Elix & Hale, *Flavoparmelia caperata* (L.) Hale, *Hypotrachyna exsplendens* (Hale) Hale, *H. imbricatula* (Zahlbr.) Hale, *H. immaculata* (Kurok.) Hale, *H. kingii* (Hale) Hale, *H. pseudosinuosa* (Asahina) Hale, *H. revoluta* (Flörke) Hale, *H. sublaevigata* (Nyl.) Hale, *Imshaugia aleurites* (Ach.) S. L. F. Meyer, *Melanelia panniformis* (Nyl.) Essl., *Myelochroa denegans* (Nyl.) Elix & Hale, *M. xantholepis* (Mont. & Bosch) Elix & Hale, *Parmelia masonii* Essl. & Poelt, *P. meiophora* Nyl., *P. praesquarrosa* Kurok., *Parmeliopsis ambigua* (Wulfen) Nyl., *Parmotrema argentinum* (Kremp.) Hale, *P. chinense* (Osbeck) Hale & Ahti, *P. corniculans* (Nyl.) Hale, *P. dilatatum* (Vain.) Hale, *P. eurysacum* (Hue) Hale, *P. exquisitum* (Kurok.) DePriest & B. Hale, *P. lobulascens* (J. Steiner) Hale, *P. overeemii* (Zahlbr.) Elix, *P. permutatum* (Stirt.) Hale, *P. robustum* (Degel.) Hale, *P. subrugatum* (Kremp.) Hale, *P. ultralucens* (Krog) Hale, *Punctelia borreri* (Sm.) Krog, *P. rudecta* (Ach.) Krog and *Rimelia clavulifera* (Räsänen) Kurok. *Xanthoparmelia formosana* Kurok. is validated by designating the holotype.

Keywords: Lichens, parmelioid, *Parmelia* and related genera, Taiwan.

INTRODUCTION

The genus *Parmelia* was first proposed by Acharius (1803) and included a large number of foliose species belonging to such diverse genera as *Cetraria*, *Heterodermia*, *Lobaria*, *Pannaria*, *Parmelia*, *Physcia* etc. In 1926, Zahlbruckner recircumscribed the genus *Parmelia.* Based mainly on morphological and chemical investigations, *Parmelia* in the sense of Zahlbruckner has been segregated into more than 30 genera by various authors in the past several decades.

For these genera the term parmelioid genera was proposed by Kärnefelt *et al.* (1992). They form the largest and most important portion of the macrolichen flora of Taiwan. In the present paper, the authors intend to enumerate all genera and species that are known from Taiwan at present, with special references to their morphological and chemical features, distribution etc.

The lichens of Taiwan received little attention from botanists in the early 20th century. Indeed, only two species of parmelioid lichens, *Parmelia cetrata* and *P. subaurulenta*, were reported by Sasaoka (1919) before 1930. However, U. Faurie, a French priest and a plant collector, visited Taiwan and collected lichens in 1903 and Asahina made an extensive collection of lichens in Taiwan from December 1933 to January 1934. When Asahina asked Zahlbruckner to identify his lichen collections, Zahlbruckner also studied some of Faurie's collections available to him. Zahlbruckner (1933) reported 260 species of lichens from Taiwan, including 21 taxa of parmelioid lichens with two new species and two new forms. Sato (1936-38), Räsänen (1940) and Inumaru (1939-41) studied Taiwanese lichens, but made no contribution to the knowledge of parmelioid lichens in Taiwan.

Dr. Yasuhiko Asahina was the first lichenologist to make extensive collections of lichens in Taiwan. He made important contributions to our knowledge of chemistry and taxonomy of Asian lichens, including that of parmelioid lichens from Taiwan. He published a number of papers, in which his own collections of parmelioid lichens from Taiwan were cited. Dr. Mason E. Hale, Jr., another prominent lichenologist, produced extensive papers on the taxonomy of *Parmelia* sens. lat. and contributed much to the fundamental understanding of their classification (cf. DePriest 1999).

The senior author made his first lichenological excursion to Taiwan in December 1963 – February 1964 and collected lichens in various parts of the island. On this excursion, he visited Mt. Morrison, Mt. Nanhutasan, Mt. Ali, Piyanan Pass, Chitou, Hengchung, Kueifu, Sun Moon Lake and the area north of Taipei. In January – February 1965 and September 1990 he made further trips to Taiwan and visited the eastern part of the island and other areas. Part of his collections have been distributed in "Lichenes Rariores et Critici Exsiccati", while his original collection is deposited at the lichen herbarium of the National Science Museum, Tokyo (TNS). Mr. K. Yoshida and Mr. H. Shibuichi collected in Taiwan in 1989 and their parmelioid lichens are also preserved in TNS.

The junior author began his lichen studies in the early 1970's (Wang-Yang & Lai 1973, 1976). He had the honour to work with the late Dr. M. E. Hale, Jr. in 1978-79 at the Smithsonian Institution, Washington, D.C., where he studied the lichen flora of Taiwan with emphasis on the taxonomy of the Parmeliaceae. In 1991, he had the opportunity to study at the Tsukuba Botanical Garden of the National Science Museum, Tokyo for three months working with the senior author on the Taiwanese parmelioid lichens. The present paper is principally based on the results obtained through this cooperative study on specimens preserved at TNS, and some selected collections made by the junior author in Taiwan.

The specimens cited below are preserved in TNS, unless indicated otherwise. The following collector abbreviations are used in this paper: YA for Y. Asahina and SK for S. Kurokawa. Collections made by the junior author and his colleagues are kept at the private herbarium of the junior author (abbreviated as Lai).

Ninety seven species belonging to nineteen genera of the parmelioid lichens are recognized. Historical remarks, taxonomic circumscriptions as well as key references for each genus are given. In addition, for each included species: nomenclature, synonymy, thalline as well as fruiting morphology, diagnostic characters, chemistry, distribution range and specimen citations are provided.

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KEY TO THE GENERA OF PARMELIOID LICHENS IN TAIWAN

1. Thallus loosely adnate, lobes linear elongate, divaricate, distinctly canaliculate below .... 4. *Cetrariastrum*

1. Thallus tightly adnate, adnate to loosely adnate, usually forming a rosette; lobes sublinear to subirregular, plane below.

  2. Thallus pale yellowish green to pale yellow, containing usnic acid in the cortex.

    3. Lobes ciliate; cilia inflated near the base (bulbate cilia) .... 17. *Relicina*

    3. Lobes eciliate.

      4. Thallus tightly adnate, subcrustose, strongly areolate in the center; cylindrical rhizines lacking .... 8. *Karoowia*

      4. Thallus closely to loosely adnate; lobes foliose at least in the periphery, with cylindrical rhizines below.

        5. Thallus saxicolous or rarely terricolous; soralia lacking .... 19. *Xanthoparmelia*

        5. Thallus corticolous or rarely saxicolous; soralia present .... 5. *Flavoparmelia*

  2. Thallus mineral grey or olive brown to dark brown.

    6. Thallus olive brown to dark brown .... 9. *Melanelia*

    6. Thallus grey to mineral grey.

7. Upper surface reticulately maculate .... 18. *Rimelia*

7. Upper surface emaculate to effigurate maculate; maculae never form reticulation when present.

  8. Upper surface effigurate maculate; short rhizines and long, coarse and thick rhizines present .... 2. *Canomaculina*

  8. Upper surface emaculate, faintly or distinctly maculate; rhizines simple or rarely furcate or squarrosely branched.

    9. Lobes rather wide, usually more than 10 mm wide, rotund at the apices; lower surface naked in a rather wide zone near the apices .... 15. *Parmotrema*

    9. Lobes rather narrow, usually less than 10 mm wide; lower surface rhizinate even near the apices.

      10. Lobes ciliate.

        11. Cilia bulbate .... 1. *Bulbothrix*

        11. Cilia not inflated at the base.

          12. Medulla pale yellow at least in part, containing secalonic acid A along with triterpenes .... 10. *Myelochroa*

          12. Medulla usually white, containing neither secalonic acid A nor triterpenes.

            13. Lobes moderately broad (3-10 mm wide), ciliate mainly in axils .... 12. *Parmelinella*

            13. Lobes narrow (less than 5 mm wide), with truncate apices evenly ciliate along the margin .... 13. *Parmelinopsis*

      10. Lobes eciliate.

        14. Lobes pseudocyphellate on the margins and/or on the upper surface.

          15. Pseudocyphellae angular to linear, rarely punctiform; conidia unciform or filiform; salazinic acid common as a secondary product ...... 11. *Parmelia*

          15. Pseudocyphellae punctiform; conidia bifusiform or cylindrical; salazinic acid absent .... 16. *Punctelia*

        14. Lobes not pseudocyphellate.

          16. Rhizines repeatedly dichotomously branched ...... 6. *Hypotrachyna*

          16. Rhizines simple or furcate.

            17. Thallus moderately adnate; lobes 2-6 mm wide, apically subrotund .. .. 3. *Canoparmelia*

            17. Thallus tightly adnate; lobes 1-2 mm, apically subtruncate.

              18. Thallus pale below; conidia bifusiform; medulla P+ red, containing thamnolic acid .... 7. *Imshaugia*

              18. Thallus black below; conidia falcate; medulla P−, containing divaricatic acid .... 14. *Parmeliopsis*

THE GENERA AND SPECIES

1. **BULBOTHRIX** Hale

Phytologia **28**: 479.1974.

Bulbothrix is primarily a tropical and subtropical genus, comprising approximately 43 species. It is characterized by lobes with bulbate cilia and a grey upper surface (containing atranorin). The lower surface may be black or pale brown and usually covered with simple, furcate or sometimes squarrosely branched rhizines. Three species are known in Taiwan and they are all isidiate. Key reference: Hale (1976b).

Key to the species

1. Rhizines richly branched; medulla C+ red, containing gyrophoric acid ... *B. goebelii*

1. Rhizines simple; medulla C−, K+ yellow turning red, containing salazinic acid.

  2. Lower surface brown .... *B. isidiza*

  2. Lower surface black with at most a narrow brown zone near the tips ... *B. tabacina*

1. **Bulbothrix goebelii** (Zenker) Hale, Smiths. Contr. Bot. **32**: 14. 1976.
Parmelia goebelii Zenker in Goebel & Kunze, Pharmac. Waarenk. 134. 1827.
Parmelia scortella Nyl., Flora 68: 615. 1885.

Thallus corticolous, closely adnate, fragile, mineral grey to olive-buff, 2-8 cm broad; lobes sublinear-elongate, 0.5-1.5 mm wide, the margins often filiform-dissected; bulbate cilia dense, becoming apically branched; upper surface plane, dull, faintly maculate, isidiate, the isidia simple or branched, cylindrical, to 0.7 mm high, sometimes blackening apically; lower surface variable, dark brown to black, moderately to densely rhizinate, the rhizines often dark brown with pale tips, or black and shiny, moderately to richly squarrosely branched. Apothecia rare, adnate to sessile, 1-2 mm in diameter, the rim ecoronate; spores 4-6 × 8-10 μm.

Chemistry: Cortex K+ yellow, medulla K−, C+ rose, KC+ red, P−; atranorin and gyrophoric acid.

The species is characterized by having a pale to dark brown lower surface and isidia and by producing gyophoric acid in the medulla.

Distribution: Pantropical: North, Central and South America, West Indies, South Africa, New Guinea, Australia, Thailand, the Philippines and Taiwan (Hale 1976b).

Specimens examined. Nantou Co.: Sun Moon Lake, *SK 1298*; Chitou, *YA s. n.* in 1933, *SK 1436*.

2. **Bulbothrix isidiza** (Nyl.) Hale, Phytologia **28**: 480. 1974.
Parmelia isidiza Nyl., Boletim da Sociedad Broteriana Coimbra 3: 130. 1884.
Parmelia subscortea Asahina, J. Jpn. Bot. 32: 99. 1957.

Thallus corticolous or rarely saxicolous, adnate, whitish grey, becoming olive bluff in the herbarium, 5-8 cm in diameter; lobes subirregular to sublinear, 2-6 mm wide, margin with dense or sparse cilia, cilia distinctly inflated at the base, 0.5-0.75 mm long; upper surface plane, continuous, faintly to distinctly maculate, densely isidiate, the isidia cylindrical, simple or branched; lower surface pale brown or darkening, moderately rhizinate, rhizines simple. Apothecia adnate, ecoronate, 2-4 mm in diameter; spores 6-8 × 9-12 μm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, KC−, P+ pale orange; atranorin and salazinic acid.

Bulbothrix isidiza is widely distributed in the tropics and is especially commmon in Africa.

Distribution: Pantropical. Taiwan (Hale 1976b).

Specimens examined. Ilan Co.: Piyanan, 1100-1300 m alt., *SK 755* (dupl. in US). Nantou Co.: Sun Moon Lake, *SK 1300, 1303*; Mt. Suishuetasan, vicinity of Sun Moon Lake, Yuchih, about 1000 m alt., *H. Shibuichi 7824*; Chitou, *YA 3324* (holotype of *Parmelia subscortea* Asahina); *SK 1384*, *1385* (dupl. in US), *1386*, *1387*. Chiayi Co.: En route from Susulu to Funchifu, 1700-2000 m alt., *SK 525*; en route from Susulu to Mt. Alisan, 2000-2200 m alt., *SK 639*. Kaohsiung Co: Sanping, about 750 m alt., *SK 2729*, *2731*; Mt. Nanfong, 800-1300 m alt., *SK 2807*, *2814*, *2817*, *2830*; the same locality, about 1200 m alt., *SK 2929*. Taitung Co: Antung Paso, 400-995 m alt., *SK 2663*, *2664*.

3. **Bulbothrix tabacina** (Mont. & Bosch) Hale, Phytologia **28**: 481. 1974.
Parmelia tabacina Mont. & Bosch in Mont., Syll. Gen. Sp. Crypt. 327. 1856.

Thallus corticolous or rarely saxicolous, adnate to closely adnate, 4-7 cm in diameter; lobes sublinear to subirregular, 1.5-5 mm wide, ciliate, cilia distinctly inflated at the base; upper surface plane, faintly to moderately maculate, sparsely isidiate, isidia simple, less than 0.5 mm high; lower surface black, shiny, rhizinate except for a narrow papillate or naked zone near the tips, rhizines simple. Apothecia adnate, ecoronate 1.5-4 mm in diameter, the amphithecium isidiate; spores 5-8 × 9-15 μm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, KC−, P+ orange; atranorin, salazinic acid and consalazinic acid.

This is another common species of the genus characterized by a black lower surface, isidia and the production of salazinic acid.

Distribution: Pantropical. New to Taiwan.

Specimens examined. Ilan Co.: Piyanan, 1100-1300 m alt., *SK 754*. Nantou Co.: Lakeside of Sun Moon Lake, *SK 1299*, *1302*. Kaohsiung Co: Sanping, about 750 m alt., *SK 2730*; Mt. Nanfong, 800-1300 m alt., *SK 2818*; Shunsan, Mt. Nanfong, about 1200 m alt., *SK 2932*.

2. **CANOMACULINA** Elix & Hale
Mycotaxon **29**: 239. 1987.
(= RIMELIELLA Kurok., Ann. Tsukuba Bot. Gard. 10: 1. 1991.)

Canomaculina is primarily a tropical and subtropical genus with some species extending their range into temperate zones. It is characterized by a pored epicortex, an effigurate maculate upper cortex, marginal cilia tapering towards the apices and dimorphous rhizines: short simple and long, coarse and ± grouped rhizines. The genus comprises ca.23 species. Three species are known in Taiwan. Key references: Kurokawa (1991); Elix (1997).

Key to the species

1. Thallus isidiate, containing norlobaridone .... *C. subtinctoria*
1. Thallus sorediate, lacking norlobaridone.
  2. Thallus black below .... *C. leucosemotheta*
  2. Thallus dark brown below or very rarely blackened centrally .... *C. subsumpta*

1. **Canomaculina leucosemotheta** (Hue) Elix, Mycotaxon **65**: 477. 1997.
Parmelia leucosemotheta Hue, Nouv. Arch. Mus. Paris, ser. 4, 1: 192. 1899.

Thallus loosely adnate; lobes rotund, 10-15 mm wide, ciliate, cilia 1.5-2.5 mm long; upper surface strongly white-maculate, sorediate, soralia formed mostly on lateral margins; lower surface black, often mottled white along the margins.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, KC−, P+ orange red; atranorin and salazinic acid.

The present species is distributed in tropical America (Mexico, Costa Rica, Haiti and Brazil) and S. Africa, and it is very common in Mexico.

Distribution: Tropical America, S Africa, Sri Lanka (Kurokawa & Mineta 1973). New to Taiwan

Specimen examined. Pintung Co.: Kural, elevation 250 m, *SK 1520*.

2. **Canomaculina subsumpta** (Nyl.) Elix, Mycotaxon **65**: 477. 1997.
Parmelia subsumpta Nyl., Flora 52: 117. 1869.
Parmotrema subsumptum (Nyl.) Hale, Mycotaxon 5: 434. 1977.
Rimeliella subsumpta (Nyl.) Kurok., Ann. Tsukuba Bot. Gard. 10: 9. 1991.

Thallus large, loosely adnate, coriaceous, 12-15 cm broad; lobes rotund, 10-12 mm wide, distinctly ciliate, cilia 1.0-1.5 mm long; upper surface strongly white-maculate, dull, sometimes reticulately fissured, sorediate, soralia linear; lower surface pale brown with blackish patches in central part, densely rhizinate. Apothecia imperforate; spores 7-10 × 12-15 μm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid and usnic acid (+or−).

Canomaculina subsumpta is very similar to *Rimelia* species, from which it differs by the brown lower surface and unique dimorphic rhizines. The *Rimelia* species have reticulate maculations and a black lower surface.

Distribution: Widely distributed in tropical America and Africa, India, Australia, Papua New Guinea and Taiwan (Kurokawa 1991).

Specimen examined. Taichung Co.: Lisan, *SK 879*.

3. **Canomaculina subtinctoria** (Zahlbr.) Elix, Mycotaxon **65**: 477. 1997.
Parmelia subtinctoria Zahlbr. in Handel-Mazzetti, Symb. Sin. 3: 193. 1930.
Parmotrema subtinctorium (Zahlbr.) Hale, Phytologia 28: 339. 1974.
Rimeliella subtinctoria (Zahlbr.) Kurok., Ann. Tsukuba Bot. Gard. 10:9. 1991.
Parmelia leucosemotheta Hue f. *isidiata* Hue, Nouv. Arch. Mus. Paris, ser. 4, 1: 192. 1899.

Thallus corticolous, saxicolous or terricolous, loosely adnate, medium-sized, 3-5 cm broad, often furrowed in the central part; lobes rotund, 10-15 mm wide, indented to crenate at the margin, sparsely ciliate, cilia 1-1.5 mm long; upper surface distinctly maculate especially in the peripheral part and often reticulately cracked, wrinkled in older parts, densely isidiate, the isidia cylindrical, simple to branched, laminal and marginal; lower surface pale brown, or brown black in the central part, rhizines dimorphic, simple, dense, rather short, dark brown, or papillate to the margins, usually with a shining narrow marginal zone. Apothecia imperforate; spores 5-8 × 8-11 ㎛.

Chemistry: Cortex K+ yellowish, medulla K+ yellow turning red to red purple, C−, P+ orange; atranorin, norlobaridone (Kurokawa 1969b), loxodin (Kurokawa 1969b; Komiya & Kurokawa 1969; Winnem 1975) and salazinic acid (+or−).

Canomaculina subtinctoria can be distinguished from similar, isidiate species by the dimorphic rhizines, maculate upper surface. It is related to the sorediate *C. subsumpta*. It is also apparently closely related to *Rimelia*. The name *Parmelia subcrinita* Nyl. (Nylander 1890) has sometimes been incorrectly used for the present species (Asahina 1961; Hale 1965), and has been rejected by neotypification (Krog 1974).

Distribution: Widely distributed in tropical regions and extending to temperate regions – North, Central and South America, Japan, India, Thailand (Pooprang *et al.* 1999), China (Zhao *et al.* 1982), Korea (Park 1990), Australia, Africa (Krog & Swinscow 1981). Taiwan (Kurokawa 1991).

Specimens examined. Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 744*. Taichung Co.: Lisan, *SK 877*, *878*. Nantou Co.: Chitou, *SK 1347*. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 136*. Taitung Co.: Chinsueiin Pass, elevation 400-1200 m, *SK 2989*. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2791*, *2837*.

3. **CANOPARMELIA** Elix & Hale
Mycotaxon **27**: 277. 1986.

Canoparmelia is characterized by apically rotund, eciliate lobes (2-5 mm wide), a pored epicortex and simple rhizines. Two (*C. ecaperata* and *C. zambiensis*) of approximately 39 species of the genus contain usnic acid, the others produce atranorin in the upper cortex. The genus seems to have its distribution center in the southern hemisphere but some species extend their ranges north to the United States in America and Japan in Asia. Two species are known in Taiwan. Key references: Hale (1976a); Elix, Johnston & Verdon (1986).

Key to the species

1. Thallus isidiate; medulla P+ orange red, containing protocetraric acid .... *C. amazonica*

1. Thallus sorediate; medulla P−, containing divaricatic acid ....*C. texana*

1. **Canoparmelia amazonica** (Nyl.) Elix & Hale, Mycotaxon **27**: 278. 1986.
   Parmelia amazonica Nyl., Flora 28: 611. 1885.
   Pseudoparmelia amazonica (Nyl.) Hale, Phytologia 29: 189. 1974.

Thallus corticolous, closely adnate, 5-10 cm broad, light mineral grey and turning buff in the herbarium; lobes subirregular, apically rotund, 2-6 mm wide, contiguous; upper surface plane, continuous, moderately isidiate, the isidia rarely branched, up to 2 mm high; lower surface black, densely rhizinate except for a narrow naked or papillate zone near the tips. Apothecia rare, 1-3 mm in diameter; spores 8-10 × 13-16 μm.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ rose, P+ red; atranorin and protocetraric acid.

The present species is very common in the neotropics, and has a disjunct range in Taiwan and China.

Distribution: United States (Florida), Central America, West Indies, Colombia, Venezuela, Brazil, Guinea, China (Ahti *et al.* 1999) and Taiwan (Hale 1976a).

Specimens examined. Pingtung Co: Kural, *YA s. n.* in 1933; the same locality, 250 m alt., *SK 1481*, *1519*.

2. **Canoparmelia texana** (Tuck.) Elix & Hale, Mycotaxon **27**: 279. 1986.
   Parmelia texana Tuck., Amer. J. Sci. Arts, ser. 2, 25: 424. 1858.
   Parmelia pseudorutidota Asahina, J. Jpn. Bot. 27: 17. 1952.
   Parmelia tanakae Asahina, J. Jpn. Bot. 29: 371. 1954.

Thallus corticolous, closely adnate, ashy white to mineral grey, 6-12 cm broad, lobes subirregular, apically rotund, 3-5 mm wide; upper surface plane to rugulose, usually deeply rimose, sorediate, the soralia laminal, punctiform to capitate, pustulate with formation of soredia; lower surface black and moderately rhizinate except for a narrow naked brown zone near the tips. Apothecia rare, 2-5 mm in diameter; spores 6-7 × 9-11 μm.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ reddish, or KC−, P−; atranorin and divaricatic acid.

Although this is one of the most widespread species of the genus, it has not been reported from Taiwan before.

Distribution: Widely distributed in tropical-subtropical regions of the world: United States, South America, Africa, Madagascar, India, Thailand, Java, Sumatra, Japan and Australia. New to Taiwan.

Specimens examined. Nantou Co: Wushe, about 1100 m alt., *H. Shibuichi 7058, 7849, 7866.*

4. **CETRARIASTRUM** Sipman

Proc. Kon. Nederl. Akad. Wetensch., ser. C, **83**: 335. 1980.
(= EVERNIASTRUM Hale ex Sipman, Mycotaxon 26: 237. 1986.)

Cetrariastrum comprises ca. 36 species and has centers of speciation in tropical America and tropical Asia. It is characterized by linear-elongate, dichotomously divided lobes with a canaliculate lower surface, marginal cilia and a pored epicortex. Five species are known in Taiwan.

According to Culberson & Culberson (1981), *Everniastrum* cannot be considered as a distinct genus and is included in *Cetrariastrum*, even though it was subsequently validated by Sipman (1986). Key references: Culberson & Culberson (1981); Kurokawa (1999b).

Key to the species

1. Thallus isidiate .... *C. vexans*
1. Thallus lacking isidia.
  2. Soredia or pustules absent.
    3. Lobes erhizinate or very rarely rhizinate on the lower surface .. *C. cirrhatum*
    3. Lobes rhizinate on the lower surface .... *C. nepalense*
  2. Thallus sorediate or pustulate.
    4. Thallus pustulate, pustules formed in groups on the upper surface .... *C. subplanum*
    4. Thallus sorediate, soredia marginal or terminal, often spreading on the upper surface.. *C. sorocheilum*

1. **Cetrariastrum cirrhatum** (Fr.) W. L. Culb. & C. F. Culb., The Bryologist **84**: 283. 1981.
Parmelia cirrhata Fr. Syst. Orb. Veg. 1: 283. 1825.
Everniastrum cirrhatum (Fr.) Hale ex Sipman, Mycotaxon 26: 239. 1986.
Parmelia cirrhata Fr. f. *vermicularis* (Vain.) Asahina, J. Jpn. Bot. 26: 102. 1951.

Thallus loosely adnate; lobes 0.5-2 (-4) mm wide, dichotomous, involute, ciliate, cilia moderate to dense, 3-4 mm long; upper surface ±maculate, isidia and soredia lacking; lower surface black, erhizinate or with very few rhizines on some lobes.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid, protolichesterinic acid, galbinic acid (trace) and protocetraric acid (trace).

Cetrariastrum cirrhatum closely resembles *C. nepalense*, from which it is distinguished by the lack of rhizines, though very rarely a few rhizines may be found.

Distribution: Japan, Korea, Taiwan (Zahlbruckner 1933), India, Central and South America.

Specimens examined. Ilan Co.: Mt. Nanhutasan, 2600-3000 m, *SK 1022*, *1193*. Nantou Co.: Chitou, *Lai 1646*, *2360*, *8292* (Lai); Sungling, *S. Asahina s. n.* in 1936. Taichung Co.: Anmasan, 2275 m, *Lai 9980* (Lai); Mt. Pasiensan, *Lai 3168* (Lai). Chiayi Co.: Mt. Alisan, *R. Imazeki s. n.* in 1963; *YA F-80*, *M. Ogata 746*, *747*, *748*, *754*, *Yasue s. n.* in 1937, *K. Mayebara* (Herb. Asahina no. *L-271*), *S. Asahina s. n.* in 1964; Mt. Alisan, 2200 m, *SK 17*, *569*, *Jen-Rong Wang Yang 653*(TNS), *T. Nakaike s. n.* in 1971, *Lai 10218*, *10161* (Lai); Tsutsonsan, Mt. Alisan, 2300-2900 m, *SK 125*, *126*, *127*, *128*, *131*, *4790*; Mt. Morrison, *Lai 10350* (Lai); Hattsukan, *T. Suzuki 749*. Taitung Co.: Bayu Lake, 2200 m, *SK 2406*; Mt. Wunitoparu, 1900 m, *SK 2588*. Kaohsiung Co.: Shunsan, Mt. Nanfong, 1200 m, *SK 2933*. Pingtung Co.: Mt. Peitawusan, *Lai 9876* (Lai).

2. **Cetrariastrum nepalense** (Taylor) W. L. Culb. & C. F. Culb., The Bryologist **84**: 301. 1981.
Parmelia nepalensis Taylor, London J. Bot. 6: 172. 1847.
Everniastrum nepalense (Taylor) Hale ex Sipman, Mycotaxon 26: 241. 1986.

Thallus loosely adnate, lobes 1-2(-4) mm wide, dichotomous, subinvolute, ciliate, cilia moderate, 1-4 mm long; upper surface ±maculate, isidia and soredia lacking; lower surface black, rhizines moderate to dense.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid, protolichesterinic acid, galbinic acid (+or−) and protocetraric acid (+or−).

Cetrariastrum nepalense is clearly distinguished from *C. cirrhatum* by the distinctly rhizinate lower surface.

Distribution: Southern China, Nepal, India, Thailand, Java, Taiwan (Zahlbruckner 1933).

Specimens examined. Chiayi Co.: Mt. Alisan, 2200 m, *Jen-Rong Wang Yang 634*(TNS), *Lai 10108* (Lai).

3. **Cetrariastrum sorocheilum** (Vain.) W. L. Culb. & C. F. Culb., The Bryologist **84**: 292. 1981.
Parmelia sorocheila Vain., Hedwigia 38: (123). 1899.
Everniastrum sorocheilum (Vain.) Hale ex Sipman, Mycotaxon 26: 242. 1986.

Thallus loosely adnate, lobes 0.5-2.5(-4) mm wide, subdichotomously divided, flat to involute, ciliate, cilia 0.5-1(-2) mm long; upper surface ±maculate, soralia subterminal to marginal; lower surface black, rhizines lacking.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid, protolichesterinic acid, galbinic acid (+or−) and protocetraric acid (+or−).

The present species is characterized by the presence of subterminal and/or submarginal soralia which sometimes spread over the upper surface.

Distribution: Widely distributed in tropical and subtropical areas: Chile, Costa Rica, Ecuador, Guatemala, Mexico, Madagascar, Tanzania, Venezuela, New Zealand, the Philippines, Java, Papua New Guinea, Taiwan (Asahina 1951a as *Parmelia cirrhata* f. *granulosa*, Kurokawa 1999b).

Specimens examined. Nantou Co.: Mt. Nanhutasan, 2400-2600 m, *SK 1023*. Chiayi Co.: Chiensan, Mt. Morrison, 3100-3300 m, *SK 248*.

4. **Cetrariastrum subplanum** (Sipman) Kurok., J. Jpn. Bot. 74: 254. 1999.
Everniastrum subplanum Sipman, Mycotaxon 26: 244. 1986.

Thallus ±loosely adnate; lobes subdichotomously divided, linear-elongate, moderately ciliate, 2.5-5 mm wide; upper surface ±faintly maculate, pustulate, the pustules laminal, formed in groups; medulla white; lower surface black, lacking laminal rhizines.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid and protolichesterinic acid.

The present species is characterized by the presence of pustules which form in groups on the upper surface. The present species may be easily confused with *C. sorocheilum*, which has subterminal and/ or submarginal soralia.

As in other species of *Cetrariastrum*, fatty acids (protolichesterinic acid and its related compounds) seem to be accessary compounds in the present species, though fatty acids were not reported in the holotype by Sipman (1986).

Distribution: The Philippines, Taiwan and Indonesia in southeastern Asia (Kurokawa 1999b), Mexico.

Specimens examined. Chiayi Co.: Mt. Alisan, 2200m, *SK 18, 19.*

5. **Cetrariastrum vexans** Zahlbr. ex W. L. Culb. & C. F. Culb., The Bryologist **84**: 294. 1981.

Parmelia vexans Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 55. 1933, nom. inval.

Everniastrum vexans (Zahlbr. ex W. L. Culb. & C. F. Culb.) Hale ex Sipman, Mycotaxon 26: 242. 1986.

Thallus loosely adnate; lobes dichotomously divided, involute or flat, 0.5-2 mm wide, ciliate, cilia moderate to dense; upper surface isidiate, isidia cylindrical; lower surface black, rhizines scattered.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid, protolichesterinic acid. Sipman (1980) mentioned three chemical strains demonstrated by TLC in the Colombian collections.

The present species is characterized by the presence of laminal isidia, the absence or sporadic presence of laminal rhizines on the lower surface and the production of salazinic and fatty acids. Although it had been considered to be endemic to Asia, Sipman (1980) reported this species from Mexico, C. America and S. America including the Galapagos Islands.

Distribution: China, Taiwan (Zahlbruckner 1933, type from Taiwan), tropical America—Mexico, Venezuela, Colombia (Sipman 1980).

Specimens examined. Ilan Co.: Mt. Nanhutasan, 1500-2400 m, *SK 933.* the same locality, 2600-3000 m, *SK 1192.* Taichung Co.: Anmasan, 2275 m, *Lai 10024* (Lai); Lisan, *SK 881.* Sungling, *S. Asahina s. n.* in 1936. Chiayi Co.: Kainoodai, Mt. Alisan, *YA F-79*; Mt. Alisan, *Lai 10189* (Lai); en route from Susulu to Mt. Alisan, 2000-2200 m, *SK 640*; Tsutsonsan, Mt. Alisan, 2300-2900 m, *SK 129*, *130*, *155.* Kaohsiung Co.: Mt. Nanfong, 1300-1500 m, *SK 2907.*

5. **FLAVOPARMELIA** Hale

Mycotaxon **25**: 604. 1986.

Flavoparmelia is a cosmopolitan and temperate genus with distribution centers in South America and Australia. It comprises ca. 30 species and is characterized by rather broad yellowish green lobes without cilia, a black or brown lower surface with a naked erhizinate zone near the tips and relatively large spores (mostly 14-20 μm long). Key references: Hale (1986), Elix & Johnston (1988).

Flavoparmelia caperata (L.) Hale, Mycotaxon **25**: 604. 1986.
Lichen caperatus L., Sp. Pl. 1147. 1753.
Parmelia caperata (L.) Ach., Meth. Lich. 216. 1803.
Pseudoparmelia caperata (L.) Hale, Phytologia 28: 189. 1974.

Thallus corticolous or saxicolous, adnate to loosely attached, yellowish green, 10-20 cm in diameter, sometimes forming even larger colonies; lobes rotund, up to 10 mm wide; upper surface plane to undulate or rugulose, pustulate, pustules often becoming sorediate and diffuse or coalescing; medulla white, rarely yellow orange at the lower half; lower surface black, moderately to sparsely rhizinate except for a narrow naked brown rugose zone along the margins, rhizines short, simple, pale brown to black. Apothecia very rare, ca. 3 mm in diameter; spores 7-10 × 15-20 μm.

Chemistry: Cortex K−, medulla K−, C−, KC+ rose, P+ red; atranorin, usnic acid, protocetraric acid and caperatic acid; if pigmented skyrin present.

Flavoparmelia caperata is the commonest and most widespread species of the genus. It is common also in Taiwan, especially in montane areas at 2300-3000 m above the sea level.

Distribution: Pantemperate on all major continents (Hale 1976a, with a world distribution map of *Pseudoparmelia caperata*). New to Taiwan.

Specimens examined. Ilan Co.: Mt. Nanhutasan, 2400-2600 m alt., *SK 1033*; *1034*. Miaoli Co.: Mt. Dapachiensan, *Lai s. n.* in 1973 (Lai). Nantou Co: Wushe, Jenaihsiang, about 1100 m alt., *H. Shibuichi 7852*. Chiayi Co: Tsutsonsan, Mt. Alisan, 2300-2900 m alt., *SK 146*; the same locality, about 2300 m alt., *H. Shibuichi 8099*; *Kao 5658, 5662*; Mt. Morrison, *Lai 10407* (Lai).

6. **HYPOTRACHYNA** (Vain.) Hale
Phytologia **28**: 340. 1974.

Hypotrachyna is characterized by the lack of marginal cilia, richly dichotomously branched rhizines, a pored epicortex, and irregular, sublinear or linear lobes. Species of the genus are widely distributed in tropical to temperate zones of the world and are particularly common in subtropical and montane-tropical areas. The genus comprises about 140 species and the center of speciation seems to be in two areas: tropical America and tropical Asia. While species with linear-elongate, divaricate lobes such as *H. caraccensis* (Taylor) Hale, *H. densirhizinata* (Kurok.) Hale, *H. lineariloba* (Kurok.) Hale, *H. longiloba* (H. Magn.) Hale, etc. are common in tropical America, species with subirregular adnate lobes and rotund apices such as *H. adducta* (Nyl.) Hale, *H. crenata* (Kurok.) Hale, *H. flexilis* (Kurok.) Hale, *H. infirma* (Kurok.) Hale etc. are common in eastern and southeastern Asia. Nineteen species are known in Taiwan. Key references: Hale (1975a); Krog & Swinscow (1979).

Key to the species

1. Thallus isidiate.
  2. Medulla P+ brick red to orange red.
    3. Medulla P+ brick red, containing stictic acid .... *H. crenata*
    3. Medulla P+ orange red, containing protocetraic acid.
      4. Medulla white throughout, caperatic acid present .... *H. koyaensis*
      4. Medulla yellow in part, containing skyrin (K+ purple) .... *H. consimilis*
  2. Medulla P−.
    5. Medulla C−, KC−, containing fatty acids .... *H. infirma*
    5. Medulla KC+ deep yellow to orange, containing barbatic acid and related substances .... *H. imbricatula*
1. Thallus lacking isidia.
  6. Thallus lacking soredia and pustules.
    7. Medulla P− .... *H. flexilis*
    7. Medulla P+ yellow turning red, brick red or orange red.
      8. Medulla K+ yellow turning red, containing norstictic and salazinic acids ....*H. sublaevigata*
      8. Medulla K− or brownish, containing protocetraric acid.
        9. Medulla white, fatty acids present .... *H. keitauensis*
        9. Medulla orange yellow in part, the pigment (skyrin) K+ purple .... *H. adducta*
  6. Thallus sorediate or pustulate.
    10. Thallus pale yellowish green, containing usnic acid .... *H. sinuosa*
    10. Thallus whitish grey to mineral grey.
      11. Upper cortex or medulla UV+.
        12. Upper cortex UV+ brilliant yellow, containing lichexanthone .... *H. osseoalba*
        12. Medulla UV+ pale white, containing alectoronic acid .. *H. exsplendens*
      11. Upper cortex and medulla UV−.
        13. Medulla pale yellow throughout .... *H. endochlora*
        13. Medulla white.
          14. Medulla P−.
            15. Medulla C+ pale yellow or pinkish red.
              16. Medulla C+ pale yellow, containing barbatic acid and related substances .... *H. exsecta*
              16. Medulla C+ pinkish red containing gyrophoric acid .... *H. revoluta*
            15. Medulla C− but KC+ pinkish red, containing lividic acid .... *H. immaculata*

14. Medulla P+ yellow turning red or orange red.
  17. Thallus pustulate, pustules usually laminal..................... *H. kingii*
  17. Thallus sorediate, soralia subterminal often capitate.
    18. Medulla K+ yellow turning red, containing salazinic acid .... *H. majoris*
    18. Medulla K− or brownish, containing protocetraric acid .... *H. pseudosinuosa*

1. **Hypotrachyna adducta** (Nyl.) Hale, Phytologia **28**: 340. 1974.
Parmelia adducta Nyl., Flora 68: 610. 1885.
Parmelia manilensis Vain., Philip. J. Sci. 4: 659. 1909.
Parmelia spectabilis Asahina J. Jpn. Bot. 26: 292. 1951.

Thallus adnate, lobes subirregular, 2-5 mm wide; upper surface emaculate, without isidia and soralia; lower surface black, rhizines moderately branched.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ red, P+ orange red; atranorin, protocetraric acid and skyrin.

Hypotrachyna adducta seems to be endemic to southeastern Asia with range extension to Papua New Guinea.

Distribution: Himalaya, Japan, the Philippines, Papua New Guinea, Nepal (Kurokawa 1993), Taiwan (Kurokawa 1979) and Thailand (Pooprang *et al.* 1999).

Specimens examined. Taipei Co.: Monhuan Lake, *Wang-Yang s. n. 1967*(Lai). Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 753*. Taoyuen Co.: Mt. Peitsatiensan, *Lai 5584* (Lai). Nantou Co.: Chitou, *SK 1361*, *1374*. Chiayi Co.: Mt. Alisan, elevation 2200 m, *SK 25*, *Lai 10154* (Lai); en route from Susulu to Funchifu, elevation 1700-2000 m, *SK 523*; en route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 635*; Mt. Kodama, Mt. Alisan, *R. Imazeki s. n.* in 1940; Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 150*; Chiensan, Mt. Morrison, elevation 3100-3300 m, *SK 257*, *258*; Mt. Alisan, *M. Ogata 2022* (syntype of *Parmelia spectabilis* Asahina); Nimandaira, Mt. Alisan, *YA 2023* (syntype of *P. spectabilis* Asahina). Kaohsiung Co.: Mt. Nanfong, *Chuang 3325* (Lai).

2. **Hypotrachyna consimilis** (Vain.) Hale, Smiths. Contr. Bot. **25**: 28. 1975.
Parmelia consimilis Vain., Acta Soc. Fauna Fl. Fenn. 7: 58. 1890.

Thallus adnate; lobes sublinear, 1-3 mm wide; upper surface emaculate, isidiate, the isidia dense, simple to branched; medulla often yellow in the lower half; lower surface black, rhizines dichotomously branched.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ red, P+ orange red; atranorin, protocetraric acid and skyrin.

Until the report of the occurrence in Papua New Guinea and Taiwan by Kurokawa (1979), the present species had long been considered to be endmic to neotropics. Recently, in addition, Sipman (1993) reported this species from Mt. Kinabalu in Sabah.

Distribution: American tropics, Papua New Guinea, Sabah and Taiwan.

Specimens examined. Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2576*, *2582*.

3. **Hypotrachyna crenata** (Kurok.) Hale, Phytologia **28**: 341. 1974.
Parmelia crenata Kurok. in Hale & Kurokawa, Contr. U.S. Nat. Herb. 36: 168. 1964.

Thallus adnate, 3-6 cm broad; lobes irregular, with rotund tips, 1.5-5.0 mm wide; upper surface smooth, not maculate, moderately isidiate, the isidia short, simple to branched; lower surface black, rhizines simple to sparsely branched.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning orange, C−, KC −, P+ pale orange; atranorin, stictic acid and norstictic acid.

Hypotrachyna crenata superficially resembles *H. koyaensis*, but the lobes are smaller and more or less sublinear. The latter species contains protocetraric and fatty acids instead of stictic acid.

Distribution: Japan, Taiwan and Nepal (Kurokawa 1988), Thailand.

Specimens examined. Nantou Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 628* (dupl. in US), *629*. Kaohsiung Co.: Shunsan, Mt. Nanfong, elevation about 1200 m, *SK 2927*.

4. **Hypotrachyna endochlora** (Leight.) Hale, Smiths. Contr. Bot. **25**: 34. 1975.
Parmelia endochlora Leight., Lich. Fl. Great Brit. Irel. Channel Isl. 140. 1871.

Thallus loosely adnate; lobes sublinear to subirregular, 2-5 mm wide; upper surface weakly to distinctly maculate, pustulate, the pustules soon becoming heavily granular-sorediate, subterminal, darkening; medulla pale yellow; lower surface black, moderately rhizinate, the rhizines densely branched.

Chemistry: Cortex K+ yellow, medulla K+ yellow, C+ orange, P−; atranorin, barbatic acid, obtusatic acid, norobtusatic acid, secalonic acid A and echinocarpic acid (+ or −).

The present species is easily distinguished by the pale yellow medulla and pustules, and densely branched rhizines.

Distribution: Mexico, Central America, Colombia, Venezuela, Brazil, western Europe, South Africa, Madagascar, St. Helena, Hawaii, Sri Lanka, Taiwan (Kurokawa & Mineta 1973).

Specimens examined. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 154* (dupl. in MEL, US); Chiensan, Mt. Morrison, alt. 3100-3300, *SK 259*. Taitung Co.: Mt. Wunitoparu, alt. 1900 m, *SK 2571*.

5. **Hypotrachyna exsecta** (Taylor) Hale, Phytologia **28**: 341. 1974.
Parmelia exsecta Taylor, London J. Bot. 6: 166. 1847.
Parmelia laevigata (Sm.) Ach. f. *esorediata* Zahlbr., Bot. Mag. Tokyo 41: 351. 1927.
Parmelia laevigata subsp. *extremi-orientalis* Asahina, J. Jpn. Bot. 26: 289. 1951.
Hypotrachyna laevigata subsp. *extremi-orientalis* (Asahina) Wang-Yang & M. J. Lai, Taiwania 21: 227. 1976.
Parmelia adjuncta Hale, Phytologia 22: 434. 1971.
Hypotrachyna adjuncta (Hale) Hale, Phytologia 28: 340. 1974.

Thallus adnate; lobes sublinear to subirregular, 2-4 mm wide; upper surface emaculate, pustules becoming sorediate, or eroding out, darkening; lower surface black, moderately rhizinate, the rhizines ± densely branched to moderately branched.

Chemistry: Cortex K+ yellow, medulla K−, C+yellow, KC+ orange, P−; atranorin, barbatic acid, 4-O-demethylbarbatic acid, obtusatic acid, norobtusatic acid and echinocarpic acid (+or−).

This is one of the commonest species in montane areas (ca. 1500-2500 m above the sea level) in Taiwan. It can be considered as a species belonging to the Sino-Himalayan element, with range extension to Japan in the north and Australia in the south.

Distribution: Widely distributed in tropical and subtropical regions of southeastern and eastern Asia and southern Pacific, including Australia (Kurokawa 1986). Taiwan (Asahina 1951c, 1952). Recently reported from Thailand (Pooprang *et al.* 1999 as *H. adjuncta*).

Exsiccata examined. S. Kurokawa: Lich. Rar. Crit. Exs., no. 26 (distributed as *Parmelia exsecta*).

Specimens examined. Ilan Co.: Between Tulisan and Hoping, Taipingsan, elevation about 2100 m, *H. Inoue 47*; Yuenyang Lake, 1670 m, *Lai 6053* (Lai). Miaoli Co.: Mt. Dapachiensan, *Lai 7821* (Lai); Mt. Chungshehsan, 2750 m, *Lai 9919* (Lai). Nantou Co.: Chitou, *SK 1360*; *YA s. n.* in 1933 (lectotype of *Parmelia laevigata* ssp. *extremi-orientalis* Asahina). Chiayi Co.: Mt. Alisan, *M. Ogata s. n.* in 1935 (syntype of *Parmelia laevigata* ssp. *extremi-orientalis* Asahina); the same locality, *YA F-60* (syntype of *Parmelia laevigata* ssp. *extremi-orientalis* Asahina); the same locality, *YA F-74* (syntype of *Parmelia laevigata* ssp. *extremi-orientalis* Asahina); the same locality, elevation 2200 m, *SK 20*, *21* (dupl. in US), *24*, *571* (dupl. in US); the same locality, elevation about 2300 m. *H. Inoue 16069*; the same locality, elevation about 2300 m, *H. Shibuichi 8094*, *8098*; the same locality, *Lai 10171*, *10156*, *10215* (Lai). Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2574*, *2580*.

6. **Hypotrachyna exsplendens** (Hale) Hale, Smiths. Contr. Bot. **25**: 37. 1975.
Parmelia exsplendens Hale in Hale & Kurokawa, Contr. U.S. Nat. Herb. 36: 174. 1964.

Thallus adnate; lobes linear, 1.5-2.5 mm wide; upper surface distinctly maculate, sorediate, soralia subterminal, large, capitate-diffuse; lower surface black, moderately rhizinate, rhizines densely branched.

Chemistry: Cortex K+ yellow, medulla K−, P−, C−, KC+ rose; atranorin, alectoronic acid and α-collatolic acid.

The present species has been known from Tropical America and Africa. This is a new record to Taiwan as well as to Asia.

Distribution: Mexico, West Indies, Guatemala, Costa Rica, South Africa. New to Taiwan.

Specimens examined. Ilan Co.: Nanhutasan, elevation 2600-3000 m, *SK 1200*. Chiayi Co.: Mt. Alisan, elevation 2200 m. *SK 23*.

7. **Hypotrachyna flexilis** (Kurok.) Hale, Phytologia **28**: 341. 1974.
Parmelia flexilis Kurok. in Hara, Flora Eastern Himalaya 607. 1966.

Thallus adnate, not isidiate or sorediate, lobes 2-3 mm wide; upper surface slightly maculate.

Chemistry: Cortex K+ yellow, medulla P−, K−, C−, KC−; atranorin and protolichesterinic acid.

The present species resembles *H. keitauensis* Asahina. They both have fairly large spores and lack isidia or soredia. *H. keitauensis* shows positive color reaction with P in the medulla, producing protocetraric acid, whereas the medulla of *H. flexilis* is P−.

Distribution: Tropical eastern Asia and Papua New Guinea. Taiwan (Kurokawa 1966).

Specimens examined. Taitung Co.: Bayu Lake, elevation about 2200 m, *SK 2396*, *2398*.

8. **Hypotrachyna imbricatula** (Zahlbr.) Hale, Smiths. Contr. Bot. **25**: 41. 1975.
Parmelia imbricatula Zahlbr., Denkschr. Akad. Wiss. Wien Math.-natur. Kl. 83: 168. 1909.
Parmelia addita Hale, Phytologia 22: 433, 1971.
Hypotrachyna addita (Hale) Hale, Phytologia 28: 340, 1974.
Parmelia orientalis Hale, Phytologia 22: 435, 1971.
Hypotrachyna orientalis (Hale) Hale, Phytologia 28: 341, 1974.

Thallus loosely attached to the substratum; lobes sublinear, obtuse in the apices, 2-4 mm wide; upper surface distinctly maculate, more or less shiny, isidiate, the isidia simple, rarely branched; lower surface black, rhizines branched.

Chemistry: Cortex K+ yellow, medulla K−, C+ yellow to orange, P−; atranorin, barbatic acid, obtusatic acid, norobtusatic acid and 4-O-demethylbarbatic acid.

The present species is characterized by the presence of dichotomous rhizines and isidia and by the production of barbatic acid. When he discussed the chemical variations of the present species, Kurokawa (1986) synonymized *Parmelia addita* Hale and *P. orientalis* Hale with the present species.

Distribution: Widely distributed in subtropical and temperate areas in the world, except for Europe. New to Taiwan.

Specimens examined. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2809*, *2826*.

9. **Hypotrachyna immaculata** (Kurok.) Hale, Smiths. Contr. Bot. **25**: 41. 1975.
Parmelia immaculata Kurok. in Hale & Kurokawa, Contr. U.S. Nat. Herb. 36: 178. 1964.

Thallus adnate; lobes linear to sublinear, elongate, 1.5-3 mm wide; upper surface emaculate, pustulate near the tips of lobes, pustules soon becoming sorediate, soralia laminal or capitate; lower surface black, rhizines dense, simple to branched.

Chemistry: Cortex K+ yellow, medula K+ reddish, C−, KC+ reddish, P −; atranorin, chloroatranorin, lividic acid, colensoinic acid, 4-O-methylphysodic acid, physodic acid, oxyphysodic acid and skyrin.

This species is characterized by having sorediate thalli of the *H. livida*-type and by producing lividic acid and the related substances. It seems to be widely but sporadically distributed in tropical areas.

Distribution: Argentina (Alder & Elix 1992), Venezuela, Brazil, South Africa (Hale 1975a), Australia (Elix & Streiman 1982), Thailand (Pooprang *et al.* 1999). New to Taiwan.

Specimens examined. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2815*. Taitung Co.: Mt. Lachialachiaerh, elevation about 1800 m, *SK 2487*.

10. **Hypotrachyna infirma** (Kurok.) Hale, Phytologia **28**: 341. 1974.
Parmelia infirma Kurok. in Hale & Kurokawa, Contr. U.S. Nat. Herb. 36: 179. 1964.

Thllus adnate to loosely adnate; lobes sublinear to irregular, obtuse at the apices, 2-4 mm wide; upper surface emaculate, isidiate, isidia ±dense, short, cylindrical; lower surface black, rhizines densely dichotomously branched.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC−, P−; atranorin, protolichesterinic acid and caperatic acid.

The present species resembles *H. koyaensis* in external apperance, spore size and the production of fatty acids. However, it is easily distinguished from the latter by the negative color reaction with P in the medulla. It also resembles *H. nodakensis* (Ashina) Hale, a Japanese species, from which it is separated by the lack of KC+ unknown substance.

When he described *Parmelia nodakensis*, Asahina (1959) cited five specimens along with the holotype collected on Mt. Nodake in Kyushu, Japan. One (Asahina *2034*) of the five specimens was collected at Chitou (Keitou), Prov. Taichung (Nantou Co. at present) in Taiwan. However, its medulla is C−, KC−, containing fatty acids and it is different from *Parmelia nodakensis*, as critically studied by Kurokawa (1966). It is identified here with *Hypotrachyna infirma*, as cited below.

Distribution: Widely distributed in tropical and substropical areas in southeastern and eastern Asia (Japan, Thailand, Indonesia, India and Taiwan (Kurokawa 1966)).

Specimens examined. Nantou Co.: Chitou, *YA 2034*, *SK 1367*, *1368*, *1369*, *1370*, *1371*, *1373*, *1437*; Wushe, Jenaihsiang, elevation about 1100 m, *H. Shibuichi 7855*.

11. **Hypotrachyna keitauensis** (Asahina) Hale, Phytologia **28**: 341. 1974.
Parmelia keitauensis Asahina, J. Jpn. Bot. 26: 293. 1951.

Thallus adnate; lobes subirregular, 2-6 mm wide, upper surface emaculate or faintly maculate, more or less shiny, lacking isidia and soredia; lower surface black, rhizines densely branched.

Chemistry: Cortex K+ yellow, medula K−, C−, KC+ brownish, P+ orange; atranorin, protocetraric acid and fatty acids.

The present species resembles both *H. adducta* and *H. flexilis*, because these three species have similar, irregular to subirregular lobes with rotund apices and form no asexual propagules. In addition, they show similar distribution patterns in south-eastern Asia. However, *H. keitauensis* is distinguished from *H. adducta* by producing fatty acids, and from *H. flexilis* by producing protocetraric acid.

Distribution: Endemic to Taiwan.

Specimens examined. Taipei Co.: Mt. Yanmingsan, elevation about 500 m, *H. Inoue 12591*; Mt. Tatunsan, elevation about 900 m, *K. Yoshida 7108*. Nantou Co.: Chitou, *YA 2026* (lectotype). Chiayi Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 633*; Chokakurai, *T. Masuda 2024* (syntype). Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2821*, *2829*; Shunsan, Mt. Nanfong, elevation about 1200 m, *SK 2928*. Taitung Co.: Shinsuiei, *T. Masuda*

2025 (syntype); Bayu Lake, elevation about 2200 m, *SK 2397*.

12. **Hypotrachyna kingii** (Hale) Hale, Phytologia **28**: 341. 1974.
Parmelia kingii Hale, J. Jpn. Bot. 43: 324. 1968.

Thallus loosely adnate, about 10 cm broad; lobes 2-5 mm wide; upper surface emaculate, pustulate; lower surface black, rhizines dichotomously branched.

Chemistry: Cortex K+ yellow, medula K+ yellow turning red, C−, P+ deep yellow turning orange; atranorin, norstictic acid and trace of salazinic acid.

This species is characterized by the presence of pustules and by the production of norstictic and salazinic acids in the medulla. Norstictic acid is a rather rare substance in the present genus.

Distribution: Thailand (Hale 1968), Indonesia. New to Taiwan.

Specimen examined. Taipei Co.: Mt. Tatunsan, elevation about 900 m, *K. Yoshida 7107*.

13. **Hypotrachyna koyaensis** (Asahina) Hale, Smiths. Contr. Bot. **25**: 44. 1975.
Parmelia koyaensis Asahina, J. Jpn. Bot. 28: 67. 1953.

Thallus adnate, lobes ± irregular, rotund in the apices, 4-10 mm wide; upper surface emaculate, isidiate, the isidia cylindrical, simple to branched; lower surface black, rhizines ± densely branched.

Chemistry: Cortex K+ yellow, medulla K−, C−, P+ orange-red; atranorin, protocetraric acid and fatty acids.

Hypotrachyna koyaensis may be the isidiate morph of *H. keitauensis*, but shows a much wider distribution in eastern Asia with disjunct range in Mexico (Hale 1975a).

Distribution: Japan, southeastern Asia, Mexico (Hale 1975a) and Taiwan (Asahina 1959).

Specimens examined. Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 752*. Nantou Co.: Chitou, *YA 2027*, *2028*, *2030*; *SK 1366*, *1372*, *1379*, *1380*. Chiayi Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 632*; Mt. Alisan, elevation 2200 m, *SK 26*, *27*, *28*, *574*, *576*; Nimandaira, Mt. Alisan, *YA F-75*, *M. Ogata 2029*; Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 151*, *152*, *487*, *488*, *492*. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2808*, *2812*, *1819*, *2822*, *2828*. Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2578*.

14. **Hypotrachyna majoris** (Vain.) Hale, Phytologia **28**: 341. 1974.
Parmelia majoris Vain., Hedwigia 37: (33). 1898.
Parmelia pseudoformosana Asahina, J. Jpn. Bot. 26: 292. 1951.

Thallus adnate, lobes sublinear, 1-3 mm wide; upper surface emaculate, sorediate, soredia laminal and submarginal, not terminal, capitate; lower surface black, rhizines sparsely branched.

Chemistry: Cortex K+ yellow, medula K+ yellow turning red, C−, KC−, P+ orange red; atranorin, salazinic acid and zeorin.

Parmelia majoris was described by Vainio from Madagascar. Asahina (1951c) described *Parmelia pseudoformosana* said to resemble *Parmelia formosana* (=*Hypotrachyna osseoalba*). However, both *P. majoris* and *P. pseudoformosana* are sorediate and produce atranorin, salazinic acid and zeorin, whereas *H. osseoalba* is pustulate and contains atranorin, lichexanthone and yellow pigments (K+ purple). Kashiwadani (1975) reduced *P. pseudoformosana* to a synonym of *P. majoris* (=*Hypotrachyna majoris*).

Hypotrachyna majoris is characterized by having a medium-sized thallus, subterminal and laminal soralia, and sparsely branched rhizines. It also resembles *H. pseudosinuosa* in the presence of subterminal and laminal soralia. However, the rhizines are sparsely branched in *H. majoris*, while they are a little more densely branched in *H. pseudosinuosa*. In addition, *H. pseudosinuosa* shows a different chemistry, containing atranorin and protocetraric acid (Kashiwadani 1975).

Distribution: Madagascar, Papua New Guinea and Taiwan (Kashiwadani 1975).

Specimens examined. Nantou Co.: Chitou, *SK 1362*, *1364*, *1375*, *1391*; *YA* (Herb. Asahina no. *33241*, holotype of *Parmelia pseudoformosana*).

15. **Hypotrachyna osseoalba** (Vain.) Park & Hale, Taxon **38**: 88. 1989.
Parmelia osseoalba Vain., Ann. Soc. Zool. Bot. Fenn. Vanamo 1: 39. 1921.
Parmelia formosana Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 57. 1933.
Hypotrachyna formosana (Zahlbr.) Hale, Smiths. Contr. Bot. 25: 38. 1975.

Thallus adnate, of the typical livida-type; lobes 1-3 mm wide; upper surface emaculate, pustulate, pustules erupting, rarely coarsely sorediate; lower surface black, rhizines moderately branched.

Chemistry: Cortex K−, medulla K+ red, C−, P− or P+ orange; lichexanthone, colensoic acid, norcolensoic acid, lividic acid, physodic acid, 4-O-methylphysodic acid, oxyphysodic acid, rarely protocetraric acid and skyrin (Elix & Engkaninan 1976).

Hypotrachyna osseoalba, a cosmopolitan species, is widely distributed in subtropical and temperate regions of the world, except for Europe. It is usually corticolous but often growing over mosses on rocks. It has dense pustules and shows yellow fluorescence under ultraviolet light.

Distribution: Widely distributed in subtropical and temperate regions. Taiwan (Zahlbruckner 1933 as *Parmelia formosana*).

Specimens examined. Ilan Co.: Between Tulisan and Hoping, Taipingsan, elevation about 2100 m, *H. Inoue 36*. Nantou Co.: Chitou, *SK 1378*, *1383*, *1435*, *Lai s. n.* in 1971 (Lai); Sun Moon Lake, *YA s. n.* in 1933 (two specimens); lakeside of Sun Moon Lake, *SK 1301*. Chiayi Co.: Mt. Alisan, elevation 2200 m, *SK 22*, *572*; en route from Susulu to Funchifu, elevation 1700-2000 m, *SK 531*; Mt. Alisan, Nimandaira, *YA 70* (isotype of *P. formosana*). Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2805*, *2810*, *2823*, *2827*, *2906*. Taitung Co.: Bayu Lake, elevation about 2200 m, *SK 2401*, *2402*, *2403*; Mt. Wunitoparu, elevation about 1900 m, *SK 2572*, *2575*, *2581*.

16. **Hypotrachyna pseudosinuosa** (Asahina) Hale, Smiths. Contr. Bot. **25**: 58. 1975.
Parmelia pseudosinuosa Asahina, J. Jpn. Bot. 26: 329. 1951.
Parmelia anaptychioides Kurok. in Hale & Kurokawa, Contr. U.S. Nat. Herb. 36: 165. 1964.

Thallus closely adnate, lobes linear, 1-4 mm wide; upper surface emaculate, soredia mainly subterminal; rhizines dense, branched.

Chemistry: Cortex K+ yellow; medulla K−, C−, KC−, P+ orange-red;

atranorin and protocetraric acid.

Hypotrachyna pseudosinuosa resembles *Myelochroa aurulenta*, but differs in the presence of dichotomously branched rhizines and a white medulla showing a P + orange-red color reaction.

Distribution: Pantropical. New to Taiwan.

Specimens examined. Nantou Co.: Mt. Nanhutasan, elevation 2400-2600 m, *SK 1029*. Chiayi Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 636*, *637*; Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 157*, *495*; Mt Alisan, elevation about 2300 m, *H. Shibuichi 8121*. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2806*, *2824*, *2825*; *Chuang 3327* (Lai). Taitung Co.: Mt Wunitoparu, elevation about 1900 m, *SK 2579*.

17. **Hypotrachyna revoluta** (Flörke) Hale, Smiths. Contr. Bot. **25**: 60. 1975.
Parmelia revoluta Flörke, Deutsche Lichenen I. 11. 1815.

Thallus loosely adnate, lobes sublinear to subirregular, ±subascending, 1-5 mm wide; upper surface emaculate, pustulate, pustules soon coarsely sorediate; lower surface black, rhizines sparsely branched.

Chemistry: Cortex K+ yellow; medulla K−, C+ rose-red, KC+ red, P−; atranorin, chloroatranorin, gyrophoric acid, 5-O-methylhiascic acid (minor), 4, 5-di-O-methylhiascic acid (trace) and umbilicaric acid (trace).

Hypotrachyma revoluta resembles *H. exsecta* in the pustulate-sorediate subapical part of the lobes, but the medulla of *H. revoluta* is C+ red, KC+ red (gyrophoric aid present).

Distribution: Cosmopolitan. New to Taiwan.

Specimens examined. Nantou Co.: Mt. Nanhutasan, elevation 2600-3000 m, *SK 1201*. Chiayi Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 638*; Tsutsonsan, Mt. Alisan, elevation 2200-2600 m, *SK 494*; Tsutsonsan, Mt. Alisan elevation 2300-2900 m, *SK 156*, *490*, *491*; Chiensan, Mt. Morrison, elevation 3100-3300 m, *SK 255*.

18. **Hypotrachyna sinuosa** (Sm.) Hale, Smiths. Contr. Bot. **25**: 63. 1975.
Lichen sinuosus Sm., Eng. Bot. 29: 2050. 1809.
Parmelia sinuosa (Sm.) Ach., Syn. Meth. Lich. 207. 1814.

Thallus pale yellowish green, adnate to loosely adnate; lobes linear, 0.7-3 mm wide, soredia subterminal, ±diffuse to ±capitate; lower surface black, rhizines ±densely dichotomously branched.

Chemistry: Cortex K−, medulla K+ yellow turning red, P+ orange; usnic acid, salazinic acid, sometimes with norstictic acid and a trace of stictic acid.

This is the only usnic acid producing species of *Hypotrachyna* in Taiwan, where it is restricted to the alpine and subalpine areas.

Distribution: Widely distributed in tropical-montane and cool temperate regions: Alaska to Mexico, West Indies, Andean region from Venezuela to Chile, Europe, southern Asia from Japan to Java, Papua New Guinea and Nepal. Taiwan (Nakanishi 1964).

Specimens examined. Nantou Co.: Mt. Nanhutasan, elevation 2400-2600 m, *SK 1030*; Mt. Nanhutasan, elevation 2600-3000 m, *SK 1197*, *1198*, *1199*. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 158*; Chiensan, Mt. Morrison, elevation 3100-3300 m, *SK 260*; Shisan, Mt. Morrison, elevation 3300-3600 m, *SK 333*.

19. **Hypotrachyna sublaevigata** (Nyl.) Hale, Smiths. Contr. Bot. **25**: 66. 1975.
Parmelia sublaevigata (Nyl.) Nyl., Ann. Sci. Nat. Bot., Ser. 5, 7: 306. 1867.
Parmelia tililacea (Hoffm.) Ach. em. Vain. var. *sublaevigata* Nyl., Synop. Meth. Lich. I: 383. 1860.

Thallus closely adnate, lobes subirregular, 2-5 mm wide; upper surface emaculate, lacking isidia and soredia; lower surface black, moderately rhizinate, rhizines densely branched.

Chemistry: Cortex K+ yellow; medulla K+ yellow turning red, C−, P+ orange-red; atranorin, salazinic acid, and norstictic acid.

Hypotrachyna sublaevigata is characterized by its subrotund, closely adnate lobes, numerous, large apothecia, and the absence of isidia and soredia.

Distribution: Warm tropical regions – Mexico, Panama, Chile, India and Africa (Krog & Swinscow 1979). New to Taiwan.

Specimen examined. Ilan Co.: Piyanan (Nansan), elevation 1100-1300 m, *SK 747*.

7. IMSHAUGIA

S. L. F. Meyer, Mycologia **77**: 337. 1985.

Imshaugia is characterized by a pored epicortex, a palisade-plectenchymatous upper cortex, emergent pycnidia and small ellipsoid spores (4 x 6 μm). It comprises three species, which are distributed in boreal regions of the northen hemisphere and cool-montane regions in the southern hemisphere. It is closely related to *Parmeliopsis*, which has immersed pycnidia and larger spores (4-6 x 12-18 μm). Key references: Meyer (1985), Hinds (1999).

Imshaugia aleurites (Ach.) S. L. F. Meyer, Mycologia **77**: 338. 1985.
Lichen aleurites Ach., Lich. Suec. Prodr. 117. 1799 ('1798').
Parmeliopsis aleurites (Ach.) Nyl., Not. Sällsk. Fauna Fl. Fenn. Förh. 8: 121. 1866.

Thallus pale grey, isidiate; lower surface whitish, pycnidia emergent; conidia bacilliform.

Chemistry: Cortex P+ yellow-orange, K+ yellow, C−; thamnolic acid, atranorin and chloroatranorin.

The present species resembles *Parmeliopsis ambigua*. They both show a similar, boreal or arctic distribution and are found in subalpine and alpine areas in Taiwan. However, this species is clearly distinguished from the latter by the formation of isidia and the production of thamnolic acid.

Distribution: Temperate regions of the world: Europe, North America, Australia, Asia—Japan, China (Ahti *et al.* 1999). New to Taiwan.

Specimen examined. Ilan Co.: En route from Suyen to Mt. Nanhutasan, Hopin, 3000 m. alt., *K. Yoshida 9831*. Chiayi Co.: Shisan, Mt. Morrison, *SK 445*.

8. **KAROOWIA** Hale

Mycotaxon **35**: 182. 1989.

Karoowia is characterized by very tightly adnate, subcrustose, yellow-green thalli, the lack of cylindrical rhizines, a pored epicortex and aspicilioid or sessile apothecia. It is primarily a South African genus, but several species are distributed in Australia, South America and eastern Asia. Key reference: Hale (1989).

Karoowia saxeti (Stizenb.) Hale, Mycotaxon **35**: 190. 1989.

Parmelia saxeti Stizenb., Ber. Tätig. St. Gall. Naturw. Gesell. 1888-1889: 153. 1890.

Parmelia squamariiformis Gyeln., Repert. Spec. Nov. Regni Veg. 36: 163. 1934.

Parmelia seto-maritima Asahina, J. Jpn. Bot. 36: 228. 1961.

Thallus saxicolous, subcrustose, pale yellow green, clearly lobate near the margins; lobes 0.4-1.1 mm wide; upper surface isidiate, the isidia subglobose to cylindrical; lower surface black, lacking rhizines but with spongy lamellar layer.

Chemistry: Stictic, constictic, hypostictic (±trace), hyposalazinic (±trace) and usnic acids.

This is the only species of *Karoowia* found in Taiwan. The type specimen of *Parmelia squamariiformis* Gyeln. was collected by U. Faurie (no. *76*) at Tamsui, northern Taiwan. The present species is easily recognized by its subcrustose, tightly adnate thalli with isidia.

Distribution: South Africa, South West Africa/Namibia and Angola, Brazil, Uruguay, Australia, Hong Kong, Taiwan (lectotype of *Parmelia squamariiformis*), Japan and India.

9.**MELANELIA** Essl.

Mycotaxon **7**: 46. 1978.

Melanelia, which comprises approximately 41 species, is characterized by olive brown to dark brown thalli (HNO_3-), a nonpored epicortex, the common occurrence of punctiform pseudocyphellae and simple rhizines. It is a cosmopolitan genus, especially common in the northern hemisphere, with centers of speciation in North American and Europe. Key references: Esslinger (1977, 1978).

Melanelia panniformis (Nyl.) Essl., Mycotaxon **7**: 46. 1978.

Parmelia prolixa f. *panniformis* Nyl., Synop. Meth. Lich. 397. 1860.

Parmelia panniformis (Nyl.) Vain., Meddeland. Soc. Fauna Fl. Fenn. 6: 124. 1811.

Thallus saxicolous, closely adnate, olive brown to brown black; lobes 0.5-1.5 mm wide, discrete to imbricate, without pseudocyphellae; projections in the lobe margins developing into finger-like lobules; lower surface black, rhizines sparse. Apothecia not seen.

Chemistry: Upper cortex K−, HNO_3-; medulla K−, C−, P−; an unidentified yellowish spot present.

Melanelia panniformis is easily distinguished by the presence of finger-like lobules and negative reactions in the medulla by K, C and P.

Distribution: Circumpolar in the northern hemisphere, North America, northern and central Europe, South America. New tò Taiwan.

Specimens examined. Taichung Co.: Hoping, en route from Tochiatunsan to Shenmajensan, 3150 m alt., *Harada 10087*. Chiayi Co.: Patungkuan, Mt. Morrison, *Lai 14453* (Lai).

10. **MYELOCHROA** (Asahina) Elix & Hale
Mycotaxon **29**: 240. 1987.

Myelochroa has a center of speciation in north-eastern Asia. It is characterized by rather narrow, grey lobes with simple cilia, simple or squarrosely branched rhizines, a pored epicortex, and a pale yellow to orange yellow medulla containing secalonic acid derivatives and triterpenes. The genus comprises 17 species. Four species are known in Taiwan. Key references: Hale (1976c), Kurokawa & Arakawa (1997).

Key to the species

1. Thallus densely lobulate, lobules marginal .... *M. xantholepis*
1. Thallus not lobulate.
  2. Thallus lacking soredia and pustules .... *M. irrugans*
  2. Thallus sorediate or pustulate.
    3. Thallus sorediate; medulla K+ yellow .... *M. aurulenta*
    3. Thallus pustulate; medulla K+ reddish purple .... *M. denegans*

1. **Myelochroa aurulenta** (Tuck.) Elix & Hale, Mycotaxon **29**: 240. 1987.
Parmelia aurulenta Tuck., Am. J. Sci. & Arts, ser. 2, 25: 424. 1858.
Parmelina aurulenta (Tuck.) Hale, Phytologia 28: 482. 1974.
Hypotrachyna aurulenta (Tuck.) Krog & Swinsc., Lichenologist 19: 420. 1987.

Thallus adnate, mineral grey; lobes 2-4 mm wide, sorediate; medulla usually pale yellow; lower surface black; rhizines simple, sometimes squarrosely branched.

Chemistry: Cortex K+ yellow; medulla K− or K+ yellow, C−, KC−, P −; atranorin, zeorin, leucotylin (+ or −), leucotylic acid (+ or −), related triterpenoids and secalonic acid A.

Myelochroa aurulenta is a cosmopolitan species known from temperate to subtropical regions in the world except for Europe. It is easily distinguished from the related species by the negative color reaction of the medulla with P, and the presence of soredia. Soredia seem to be initiated from pustules and usually form masses of soralia. Soralia are variable in shape and normally laminal and subterminal; laminal soralia are rounded and often diffuse, while subterminal soralia are often inflated and capitate.

Distribution: Eastern and south-eastern Asia: Japan, Siberia, Korea, China, Taiwan (Zahlbruckner 1933), Hong Kong, Pakistan, Nepal, India, Sri Lanka, Java, the Philippines, New Guinea, Easten Africa including Madagascar, Hawaii, Canada, U.S.A., Mexico and South America, Australia.

Specimens examined. Taipei Co.: Wulai, *SK 3040*; Yunhodon, 400 m alt., *Koponen s. n.* in 1970 (H). Hsinchu Co.: Chunan, *Y. Shimada* (Herb. Asahina no. *F-82*). Taichung Co.: Lisan, *SK 874*. Nantou Co.: Chitou, *SK 1359*, *1390*; the same locality, *Lai 2711* (Lai). Chiayi Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 620*, *621*; en route from Susulu to Funchifu, elevation 1700-2000 m, *SK 527*; Chiensan, Mt. Morrison, elevation 3100-3300 m, *SK 259*. Kaohsiung Co.: Sanping, elevation about 750 m, *SK 2734*; en route from Ryuhkuei to Sanping, elevation 400-750 m, *SK 2694*. Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2571*.

2. **Myelochroa denegans** (Nyl.) Elix & Hale, Mycotaxon **29**: 240. 1987.
Parmelia denegans Nyl., Acta Soc. Sc. Fenn. 26: 6. 1900.

Thallus adnate, mineral grey; lobes sublinear, 1-3 mm wide, ciliate, cilia 0.4-0.7 mm, pustulate, pustules forming soredia; medulla yellow-ochre, K+ wine red; lower surface black, rhizines simple to squarrosely branched.

Chemistry: Cortex K+ yellow; medulla K+ reddish purple, C−, P−; atranorin, zeorin, leucotylin (+or−), leucotylic acid (+or−), leucotylin monoacetate, related triterpenoids, secalonic acid A and an unidentified anthraquinone.

Myelochroa denegans is characterized by having pustules on the lobes and producing a reddish-ochre pigment (K+ wine red) in the lower part of the medulla (Hale 1976c). The lobes are pustulate-sorediate and the soredia more or less farinose. It is distinguished from the most similar species, *M. aurulenta*, by the production of K+ pigment in the medulla.

Distribution: Southeastern Asia—India, Sri Lanka, Indonesia; Australia. New to Taiwan.

Specimens examined. Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 751*. Nantou Co.: Chitou, *SK 1376*. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 160*; en route from Susulu to Funchifu, elevation 1700-2000 m, *SK 526*. Pingtung Co.: Chinsueiin Pass, elevation 400-1200 m, *SK 2992*.

3. **Myelochroa irrugans** (Nyl.) Elix & Hale, Mycotaxon **29**: 241. 1987.
Parmelia irrugans Nyl., Lich. Jap. 26. 1890.
Parmelia homogenes Nyl., Flora 68: 607. 1885.
Parmelina homogenes (Nyl.) Hale, Phytologia 28: 482. 1974.
Parmelia homogenes Nyl. f. *minor* Asahina, Lichens of Japan 78. 1952.
Parmelia subaurulenta Nyl., Flora 68: 606. 1885.
Myelochroa subaurulenta (Nyl.) Elix & Hale, Mycotaxon 29: 241. 1987.
Parmelia subaurulenta Nyl. var. *myriocarpa* Asahina, J. Jpn. Bot. 26: 227. 1951.
Parmelia myriocarpa (Asahina) J. D. Zhao, Act. Phytotax. Sin. 9: 149. 1964.
Parmelina crassata Hale, Smiths. Contr. Bot. 33: 22. 1976.
Parmelia crassata (Hale) J. C. Wei & Y. M. Jiang, Lichens of Xizang 43. 1986.
Myelochroa crassata (Hale) Elix & Hale, Mycotaxon 29: 240. 1987.

Thallus adnate to loosely adnate, glaucous to mineral grey; lobes sublinear to subirregular, often imbricate, 2-4(-5) mm wide; upper surface plane and continuous, lacking isidia and soredia; medulla usually pale yellow; lower surface black, moderately rhizinate, the rhizines mostly simple and rarely squarrosely branched. Apothecia substipitate, 2-10 mm or more in diameter in mature stage; spores 7-10 × 11-16 µm.

Chemistry: Cortex K+ yellow; medulla K+ deep yellow, C+ deep yellow, P−; atranorin, zeorin, leucotylin (+or−), leucotylic acid (+or−), related terpenes and secalonic acid A.

Myelochroa irrugans is extremely variable in adnation of the thallus, width and thickness of lobes and size of apothecia, as discussed by Kurokawa & Arakawa (1997).

Distribution: Japan, Korea, Saghalien, China, Taiwan (Asahina 1951b as *P. subaurulenta*), Nepal, India and Thailand.

Specimens examined. Ilan Co.: Mt. Nanhutasan, elevation 2600-3000 m, *SK 1208*, the same locality, *Lai 9070* (Lai); Piyanan, *SK 751*. Chiayi Co.: Mt. Alisan, 2300 m, *Koponen 17260* (H); en route from Susulu to Funchifu, *SK 526*. Taichung Co.: Lisan, *SK 873*. Nantou Co.: Chitou, *SK 1376*; Sun Moon Lake, *H. Shibuichi 7811*. Taitung Co.: Chinsueiin, *SK 2992*.

4. **Myelochroa xantholepis** (Mont. & Bosch) Elix & Hale, Mycotaxon **29**: 241. 1987.

Parmelia xantholepis Mont. & Bosch in F. Junghuhn, Plantae Junghuhnianae 428. 1855.

Parmelina xantholepis (Mont. & Bosch) Hale, Phytologia 28: 438. 1974.

Thallus adnate, greenish grey; lobes narrow and thin, 1-3 mm wide, densely lobulate toward the lobe margins; cilia coarse, 0.2-0.8 mm long; lower surface black, rhizines simple or sometimes squarrosely branched.

Chemistry: Cortex K+ yellow, medulla K+ yellow, C+ deep yellow, P−; atranorin, zeorin, leucotylin, related triterpenes and secalonic acid A.

The present species is distinctive in forming numerous lobules often less than 1 mm wide.

Distribution: Endemic to south-eastern Asia known from Nepal, India, Indonesia, Thailand and the Philippines. New to Taiwan.

Specimens examined. Ilan Co.: Mt. Nanhutasan, elevation 2400-2600 m, *SK 1031*. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2200-2600 m, *SK 486*, *489*; the same locality, elevation 2300-2900 m, *SK 159*; Funchifu, Mt. Alisan, *Lai 3049* (Lai). Kaohsiung Co.: Mt. Nanfong, elevation 800-1300m, *SK 2835*, *2905*.

11. **PARMELIA** Ach.

Meth. Lich. 153. 1803.

Parmelia is a cosmopolitan genus which comprises 47 species. It is characterized by linear, effigurate or rarely punctiform pseudocyphellae, a non-pored epicortex and a prosoplectenchymatous upper cortex. It has two centers of speciation, Asia and Australasia. Ten species are known in Taiwan. One of them (*P. niitakana*) is apparently endemic to Taiwan, some of them are also common in Japan, and others belong to the Sino-Himalayan element. Key references: Hale (1987), Kurokawa (1994a, 1994b, 1994c, 1994d, 1994e).

Key to the species

1. Pseudocyphellae punctiform, formed on lobe margins; asci clavate to subclavate.
  2. Thallus with coralloid-isidioid outgrowths apically crumbling and subsorediate; gyrophoric acid present .... *P. isidioclada*
  2. Thallus lacking isidioid outgrowth and soredia; gyrophoric acid lacking .... *P. laevior*
1. Pseudocyphellae angular or linear, marginal and/ or laminal; asci cylindrical.
  3. Thallus isidiate, pustulate or sorediate.
    4. Thallus isidiate; isidia short and bulbate .... *P. meiophora*
    4. Thallus pustulate; pustules opened at apices and becoming sorediate .... *P. erumpens*
  3. Thallus lacking asexual propagules.
    5. Thallus tawny- to dark-brown, fumarprotocetraric acid present .... *P. masonii*
    5. Thallus ashy-grey but rarely dark-brown in part, salazinic acid present.
      6. Rhizines simple or furcate, squarrosely branched rhizines lacking.
        7. Pseudocyphellae marginal, forming a continuous white rim; amphithecium distinctly rugose to sublobulate .... *P. niitakana*
        7. Pseudocyphellae laminal as well as marginal; amphithecium more or less rugose, but never ridged .... *P. adaugescens*
      6. Squarrosely branched rhizines present.
        8. Laminal pseudocyphellae small and numerous .... *P. submutata*
        8. Laminal pseudocyphellae scattered.
          9. Lobes irregular to sublinear, more less serrate at the margins; pseudocyphellae more or less white rimmed but not elevated .... *P. praesquarrosa*
          9. Lobes sublinear-elongated, subentire at margins; pseudocyphellae conspicuously white-rimmed and elevated .... *P. subdivaricata*

1. **Parmelia adaugescens** Nyl., Lich. Jap. 28. 1890.
Parmelia pseudomarmariza D. D. Awasthi, Biol. Mem. 1: 186. 1976.

Thallus adnate, lobes 2-5 mm wide, isidia and soredia absent, pseudocyphellae marginal and laminal, often forming a loose network; lower surface black, rhizines simple or furcate or dichotomous. Spores 13-15 × 21-27 μm. Conidia cylindrical.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid and consalazinic acid.

The present species is distinctive in the uniformly dispersed pseudocyphellae. It resembles *P. fertilis*, but is distinguished by the large spores and the lack of squarrose rhizines.

Distribution: Nepal, Pakistan, Japan, Taiwan (Asahina 1952).

Specimens examined. Ilan Co.: Mt. Nanhutasan, elevation 2600-3000 m, *SK 1209*, *1210*, *1212*, *1213* (dupl. in US). Hsinchu Co.: Mt. Tapachiensan, *s. c. & s. n.* in 1932; the same locality, Lai *7811* (Lai). Taichung Co.: Anmasan, *Lai 6874* (Lai), *6875* (Lai, dupl. in US). Chiayi Co.: Mt. Morrison, *S. Sasaki* (Herb. Asahina no. *F-404*, *406*); Rohnohkei, elevation 3200 m, Mt. Morrison, *T. Suzuki* (Herb. Asahina no. *10901*); Mt. Alisan, *YA s. n.* in 1925; Shisan, Mt. Morrison, elevation 3300-3600 m, *SK 334*, *336*; Mt. Morrison, *R. Imazeki*, *s. n.*; the same locality, *Lai 10439*, *10440*, *10460* (Lai); Mt. Morrison, elevation 3600-3900 m, *SK 388* (dupl. in LD, UPS), *389*, *390*, *391*, *392* (dupl. in H); Mt. Chungyangchiensan, elevation 3100 m, *T Suzuki s. n.* in 1936. Taitung Co.: Bayu Lake, elevation about 2200 m, *SK 2404* (dupl. in M), *2405*.

2. **Parmelia erumpens** Kurok., Lich. Rar. Crit. Exs., fasc. **2**: 3. 1969.

Thallus adnate to loosely adnate; lobes 2-8 mm wide, subirregular, pustulate, pseudocyphellae laminal and maginal; lower surface black, rhizines simple or squarrose. Spores 6.5-8 × 9.5-12 µm. Conidia cylindrical to weakly bifusiform.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, chloroatranorin, salazinic acid and consalazinic acid.

The present species is distinguished by the deeply reticulate-fissured cortex and coarse, pustulate soredia. It resembles *P. squarrosa* but it is readily distinguished by the presence of pustules.

Distribution: Australia, New Zealand, South Africa, India, Nepal, Indonesia (Sumatra, Java), Papua New Guinea, Japan and Taiwan (Kurokawa 1969a).

Specimen examined. Nantou Co.: En route from Lolo to Tuikuan, elevation about 1790 m, *S. Nakanishi 12736*.

3. **Parmelia isidioclada** Vain., Bot. Mag. Tokyo **35**: 48. 1921.

Parmelia yasudae Räsänen, J. Jpn. Bot. 16: 84. 1940.
Parmelia psoromoides Räsänen, Arch. Soc. Zool.-Bot. Fenn. Vanamo 3: 79. 1949.

Thallus loosely adnate; lobes 2-4 mm wide, with isidioid outgrowths (granular or subcylindrical) apically, subsorediate along the margins, pseudocyphellae punctiform, entirely marginal, sparse, scattered; lower surface black, rhizines simple to furcate. Spores 13-16 × 23-30 µm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, gyrophoric acid, salazinic acid and consalazinic acid.

The present species is distinctive in the marginal, granular isidia and lateral, punctate pseudocyphellae.

Distribution: Temperate to montane-tropical regions – Alaska, Japan, China, Taiwan (Kurokawa 1994b).

Specimen examined. Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2587*.

4. **Parmelia laevior** Nyl., Lich. Jap. 28. 1890.

Parmelia laevior f. *denigrata* Hue., Nouv. Arch. Mus. Paris, ser. 3, 1: 166. 1899.
Parmelia petrophila Vain., Bot. Mag. Tokyo 35: 48. 1921.
Parmelia hakonensis Zahlbr., Bot. Mag. Tokyo 41: 348. 1927.
Parmelia laevior f. *hakonensis* (Zahlbr.) Asahina, Lich. Japan 112. 1952.
Parmelia ontakensis Asahina, J. Jpn. Bot. 29: 323. 1954.

Thallus loosely adnate, lobes 1.5-4 mm wide, isidia and soredia absent, pseudocyphellae puntiform, forming conspicuous dots on the margins; lower surface black; rhizines simple, furcate, rarely squarrose. Spores 8-9 × 14-16 μm. Conidia cylindrical.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid and consalazinic acid.

The present species is recognized by the marginal, punctate pseudocyphellae and absence of isidia.

Distribution: Japan, China, Taiwan (Zahlbruckner 1933).

Specimen examined. Chiayi Co.: Mt. Morrison, *S. Sasaki s. n.* (Herb. Asahina no. *F-405*).

5.**Parmelia masonii** Essl. & Poelt, Bryologist **94**: 203.1991.

Thallus loosely to moderately adnate, tawny- to dark-brown; lobes 1-3 mm wide, with no soredia and isidia; upper surface pseudocyphellate, pseudocyphellae angular to linear, marginal and laminal; lower surface black, rhizines simple to furcate.

Chemistry: Cortex K−, medulla K−, C−, P+ orange red; fumarprotocetraric acid (+or−), protocetraric acid (+or−) and fatty acids (+or−).

This species may be confused with species of *Neofuscelia* because of the dark brown color of the thallus. However, the presence of distinctive linear pseudocyphellae shows it to belong to *Parmelia*, in which fumarprotocetraric acid is a rare secondary product.

The present species has been known only from the Himalayas (Esslinger & Poelt 1991) including Yunnan (Ahti *et al.* 1999), but the range now includes Taiwan.

Distribution: Nepal and Yunnan. New to Taiwan.

Specimens examined. Chiayi Co.: Mt. Morrison, trail from Paiyun cottage to main peak, ca. 3700-3800 m, *Stenroos 3254, 3284* (H).

6. **Parmelia meiophora** Nyl., Lich. Ins. Guin. 45. 1889.

Parmelia meiophora var. *isidiata* J. D. Zhao, Acta Phytotax. Sin. 9: 156. 1964.

Thallus loosely adnate; lobes subirregular, 3-5 mm wide, isidia bulbate and short, laminal pseudocyphellae numerous and small; lower surface black, densely rhizinate, the rhizines richly squarrosely branched. Spores 5-6 × 7-8 μm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid and consalazinic acid.

The present species is regarded as the isidiate morph of *Parmelia submutata*.

Distribution: Nepal, China (Yunnan). New to Taiwan.

Specimen examined. Ilan Co.: Mt. Nanhutasan, elevation 2600-3000 m, *SK 1205*. Taichung Co.: Lisan, *SK 875*. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 148*.

7. **Parmelia niitakana** Asahina, J. Jpn. Bot. **26**: 332. 1951.

Parmelia shinanoana f. *calvescens* Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 56. 1933.

Thallus loosely adnate, 6-10 cm broad; lobes sublinear, 1.5-3 mm wide, isidia and soredia absent, pseudocyphellae marginal, forming a continuous white rim;

lower surface black, densely rhizinate, rhizines simple to furcate. Amphithecium rugose-sublobulate; spores 17-23 × 28-40 µm. Conidia cylindrical.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic and consalazinic acid.

The present species is characterized by having lobes with a conspicuous white marginal rim formed by the continuous linear pseudocyphellae, and by forming apothecia with a rugose-sublobulate amphithecium and by producing large spores. It is closely related to *P. shinanoana* Zahlbr., a species endemic to Japan, because these two species have similar, continuously white-rimmed lobes. However, it is easily distinguished from the latter by apothecia with a rugose, sublobulate amphithecium and much larger spores.

Distribution: Endemic to Taiwan.

Specismen examined. Ilan Co.: Mt. Nanhutasan, elevation 2600-3000 m, *SK 1211* (dupl. in US). Miaoli Co.: Mt. Dapachiensan, *Lai 7803* (Lai). Chiayi Co.: Hattsukan, Mt. Morrison, *T. Suzuki s. n.* in 1935; *R. Imazeki s. n.* in 1940; Mt. Morrison, elevation 3600-3900 m, *SK 393* (dupl. in US); Sokei, Mt. Morrison, *K. Kumada* (Herb. Asahina no. *23712*—holotype); Mt. Morrison, *S. Sasaki* (Herb. Asahina no. *F-403*, isolectotype of *P. shinanoana* f. *calvescens*); *Hsu 1374*. Hualien Co.: Mt. Chuosenzan, *T. Suzuki s. n.* in 1936.

8. **Parmelia praesquarrosa** Kurok., J. Jpn. Bot. **69**: 264. 1994.

Thallus adnate, lobes subirregular to sublinear, 2-4 mm wide, more or less crenate at the margin, lacking isidia and soredia, pseudocyphellae laminal and marginal, angular to sublinear, not elevated; lower surface black, moderately to densely rhizinate, the rhizines often squarrosely branched. Spores 7-10 × 11-16 µm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ organge red; atranorin, salazinic acid and protocetraric acid (trace).

The present species may be confused with *P. subdivaricata*, another species of *Parmelia* commonly distributed at higher elevations in Taiwan. See the discussion under *P. subdivaricata*.

Distribution: Eastern Asia (Saghalien, Japan and Korea). New to Taiwan.

Specimens examined. Ilan Co.: En route from Suyen to Mt. Nanhutasan, Hopin, elevation about 3000 m, *K. Yoshida 9814*, *9831*; the same locality, elevation about 3100 m, *K. Yoshida 9815*, *9816*; the same locality, elevation about 2750 m, *K. Yoshida 9813*. Hwalien Co.: Mt. Hohuansan, Hsiulinhsiang, elevation about 3200 m, *H. Shibuichi 9006*.

9. **Parmelia subdivaricata** Asahina, J. Jpn. Bot. **26**: 356. 1951.

Thallus adnate to loosely adnate; lobes sublinear elongate, subdivaricate, apically rotund, 1.5-3 mm wide, pseudocyphellae marginal and laminal, distinctly white-rimmed, the white rim well elevated and conspicuous; lower surface black, densely rhizinate, the rhizines simple or densely squarrosely branched. Spores 6-7 × 10-13 µm.

Chemistry: Thallus K+ yellow, medulla K+ yellow turning red, C−, P+ orange red; atranorin, salazinic acid and protocetraric acid (trace).

Hale (1987) treated the present species as a synonym of *P. fertilis* Müll. Arg. (= *P. praesquarrosa* in this paper), since these two species have squarrosely branched rhizines and form spores of similar size. However, the present species is clearly separated from the latter by its more linear-elongate lobes with subentire margins, more distinct and rather continuous marginal pseudocyphellae and distinctly white-rimmed and elevated laminal pseudocyphellae.

Zahlbruckner (1933) reported the occurrence of *Parmelia marmariza* Müll. Arg. from Taiwan, citing *Asahina F-71* and *F-406*. However, when Asahina (1951d) described *P. subdivaricata*, he cited *Asahina F-71* as one of the type specimens, a specimen that was later designated as the lectotype by Hale (1987).

Distribution: Japan, Taiwan.

Specimens examined. Chiayi Co.: Nimandaira, Mt. Alisan, *YA F-71* (lectotype). Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2583*, *2584*, *2585*, *2586*; the same locality, elevation about 1800 m, *SK 2490*, *2491*.

10. **Parmelia submutata** Hue, Nouv. Arch Mus. Paris ser. **3,1**: 172. 1899.
Parmelia rhododendri Zahlbr. in Handel-Mazzetti, Symb. Sin. 3: 187. 1930.
Parmelia leiocarpodes Zahlbr., Hedwigia 74: 207. 1934.

Thallus adnate to closely adnate; lobes 2-5 mm wide, imbricate; pseudocyphellae numerous and small; lower surface black, densely rhizinate, rhizines squarrosely branched. Conidia cylindrical. Spores 3-5 × 6-9 µm.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, P+ orange; atranorin, salazinic, consalazinic acid and norstictic acid (+or−).

This species is the non-isidiate and non-sorediate morph of *Parmelia meiophora*.

Distribution: Nepal, China. Taiwan (Hale 1987).

Exsiccata examined. S. Kurokawa: Lich. Rar. Crit. Exs., no. 38.

Specimens examined. Ilan Co.: Mt. Nanhutasan, elevation 2600-3000 m, *SK 1203*, *1204*, *1207* (dupl. in US); elevation 1500-2400 m. *SK 929* (dupl. in US), *930*, *931* (dupl. in US), *932* (dupl. in US). Miaoli Co.: Mt. Dapachiensan, *Lai 7827* (Lai). Taichung Co.: Mt. Hsuehsan, *Lai 9309* (Lai); Lisan, *SK 872* (dupl. in US), *875*. Chiayi Co.: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 148*, *149*; Chiensan, Mt. Morrison, elevation 3100-3300 m, *SK 254* (dupl. in US), *256*; Mt. Alisan, *M. Ogata s. n.* in 1935.

12. **PARMELINELLA** Elix & Hale
Mycotaxon **29**: 241. 1987.

The genus *Parmelinella* comprises five species and has its distribution center in India. It is characterized by rather broad lobes with simple cilia in axils, a pored epicortex, simple rhizines and a yellowish grey upper cortex (containing secalonic acid A and atranorin). One species is known in Taiwan. Key references: Hale (1976c), Elix & Hale (1987).

Parmelinella wallichiana (Taylor) Elix & Hale, Mycotaxon **29**: 242. 1987.
Parmelia wallichiana Taylor, London J. Bot. 6: 176. 1847.
Parmelina wallichiana (Taylor) Hale, Phytologia 28: 483. 1974.
Pseudoparmelia wallichiana (Taylor) Krog & Swinscow, Lichenologist 19: 424. 1987.
Parmelia nimandairana Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 55. 1933.

Thallus corticolous or saxicolous, foliose, 10-20 cm in diameter, mineral grey to yellowish glaucous, lobes rotund to subround, 3-10 mm wide, short ciliate in axils, cilia ca. 0.5 mm long; upper surface shining, rugulose in older part, isidia dense in the older part of thallus, simple to branched, simple isidia cylindrical, about 0.3 × 0.9 mm in size; medulla white; lower surface black, rhizinate in the central part, often dark tan, shining, erhizinate or with rhizinal papillae in marginal zone, the rhizines simple, black. Apothecia rare, adnate, up to 15 mm in diameter, imperforate, disc brown to dark brown; spores simple, oval ellipsoid, 8-10 × 14-18 ㎛.

The present species is characterized by cylindrical isidia and cilia restricted to the notches or axils (not on rounded lobes as in the *Parmotrema*).

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C− KC−, P+ orange; atranorin, secalonic acid A, salazinic acid and consalazinic acid. .

Distribution: Central and southern Africa, Madagascar, southern and eastern Asia (Japan, Taiwan and southern-most part of NE China), southern Pacific area including Papua New Guinea and Cape York Peninsula of Australia, but it is not known from the New World (Kurokawa 1967, with a distribution map of *Parmelia wallichiana*).

Specimens examined. Ilan Co.: Piyanan, 1100-1300 m alt., *SK 746*. Taichung Co.: Mt. Pasiensan, *Lai 3324* (Lai). Nantou Co.: Chitou, *H. Masuda s. n.* in 1933; *YA* s. *n.* in 1933; *SK 1365*, *1377*, *1388*, *1389* (dupl. in US). Chiayi Co.: En route from Susulu to Funchifu, 1700-2000 m alt., *SK 530*; Mt. Alisan, 2200 m alt., *SK 29*, *31*, *32* (dupl. in US) *573*, *575*; En route from Susulu to Mt. Alisan, 2000-2200 m alt., *SK 615*, *623* (dupl. in US), *624*, *625* (dupl. in US), *626* (dupl. in US), *627*, *630*, *631*, *634*; Mt. Alisan, *YA F-63* (isolectotype of *Parmelia nimandairana* Zahlbr.); the same locality, about 2300 m alt., *H. Shibuichi 8097*; Tsutsonsan, Mt. Alisan, *SK 147*, *153*, *485* (dupl. in US). Kaohsiung Co.: Sanping, about 750 m alt., *SK 2728*; Mt. Nanfong, 800-1300 m alt., *SK 2804*, *2813*, *2831*, *2816*; Shunsa, Mt. Nanfong, about 1200 m alt., *SK 2925*. Taitung Co.: Bayu Lake, about 2200 m alt., *SK 2394*, *2395*; Mt. Lachialachiaerh, about 1800 m alt., *SK 2488*, *2489*; Mt. Lachialachiaerh, 1800-2200 m alt., *SK 2354*; Mt. Lachialachiaerh, about 1900 m alt., *SK 2570*; Antung Paso, 400-995 m alt., *SK 2663*, *2664*.

13. **PARMELINOPSIS** Elix & Hale
Mycotaxon **29**: 242. 1987.

Parmelinopsis comprises 24 species and shows a pantemperate to pantropical distribution. It is characterized by narrow, grey lobes with truncate apices, a pored epicortex, simple cilia, simple to furcate rhizines and rather large spores (8-12 × 12-18 ㎛). Four species are known in Taiwan. Key references: Hale (1976c), Elix & Hale (1987).

Key to the species

1. Thallus pale brown to brown below; medulla C−, KC− .... *P. expallida*
1. Thallus black below; medulla C+ rose or KC+ rose.
  2. Thallus pustulate .... *P. spumosa*
  2. Thallus isidiate.
    3. Isidia often ciliate; medulla C−, KC+ rose .... *P. horrescens*
    3. Isidia eciliate; medulla C+ rose .... *P. minarum*

1. **Parmelinopsis expallida** (Kurok.) Elix & Hale, Mycotaxon **29**: 242. 1987.
Parmelia expallida Kurok., Bull. Nat. Sci. Mus., Tokyo 11: 191. 1968.
Parmelina expallida (Kurok.) Hale, Phytologia 28: 482. 1974.

Thallus adnate, of the *Hypotrachyna livida*-type; lobes 1-3 mm wide, ciliate, cilia sparse, dark brown to black; upper surface emaculate, isidiate, isidia cylindrical, often branched; lower surface pale brown, moderately rhizinate, rhizines simple, pale to brown.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC−, P−; atranorin and protolichesterinic acid.

This species was described on the basis of a specimen collected in Taiwan (Kurokawa 1968a). An unusual feature of this species is the brown lower surface, indicating a relationship with *P. protocetrarica* Elix.

Distribution: India, Thailand and Taiwan (Kurokawa 1968a).

Specimens examined. Nantou Co.: Chitou, *SK 1382* (paratype); *YA s. n.* in 1933. Kaohsiung Co.: Shunsan, Mt. Nanfong, about 1200 m, *SK 2930* (holotype).

2. **Parmelinopsis horrescens** (Taylor) Elix & Hale, Mycotaxon **29**: 242 1987.
Parmelia horrescens Taylor in Mackay, Flora Hibern. 144. 1836.
Hypotrachyna horrescens (Taylor) Krog & Swinscow, Lichenologist 19: 420. 1987.

Thallus adnate; lobes sublinear, imbricate, 0.5-2 mm wide, ciliate; upper surface more or less shiny, emaculate, isidia cylindrical, often branched, apically spinulate or short-ciliate; lower surface black, rhizines black, simple.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ rose or red, P−; atranorin, 3-methoxy-2, 4-di-O-methylgyrophoric acid, gyrophoric acid (trace) and 4-5-di-O-methylhiascic acid (trace).

Parmelinopsis horrescens closely resembles *P. minarum*, another cosmopolitan species, in morphology. However, it is readily distinguished from the latter by ciliate isidia and the negative color reaction with C in the medulla.

Distribution: Pantemperate and montane pantropical. Taiwan (Hale 1976c).

Specimens examined. Chiayi Co.: Mt. Alisan, 2200 m, *SK 30*; Tsutsonsan, Mt. Alisan, 2200-2600 m, *SK 493*; en route from Susulu to Mt. Alisan, 2000-2200 m, *SK 693*. Ilan Co.: Piyanan, 1100-1300 m, *SK 756*. Taitung Co.: Mt. Wunitoparu, about 1900 m, *SK 2577*.

3. **Parmelinopsis minarum** (Vain.) Elix & Hale, Mycotaxon **29**: 243. 1987.
Parmelia minarum Vain., Acta Soc. Faun. Flora Fenn. 7: 48. 1890.
Parmelina minarum (Vain.) Skorepa, Phytologia 53: 445. 1983.
Hypotrachyna minarum (Vain.) Krog & Swinscow, Lichenologist 19: 420. 1987.
Parmelia dissecta Nyl., Flora 65: 451. 1882.
Parmelina dissecta (Nyl.) Hale, Phytologia 28: 482. 1974.

Thallus adnate; lobes sublinear, 1-3 mm wide, ±imbricate, ciliate at the margins; upper surface shiny, emaculate, isidia simple to branched; lower surface black, moderately rhizinate, rhizines black, simple or sparsely branched.

Chemistry: Cortex K+ yellow, medulla K−, C+ rose, KC+ red, P−; atranorin, gyrophoric acid, 5-O-methylhiascic acid (minor), 4-5-di-O-methylhiascic acid (trace) and umbilicaric acid (trace).

This species is easily confused with *P. horrescens*, for differences see under that species.

Distribution: Pantemperate and montane pantropical. Taiwan (Hale 1976c, as *Parmelina dissecta*).

Specimen examined. Taitung Co.: Bayu Lake, about 2200 m, *SK 2400*.

4. **Parmelinopsis spumosa** (Asahina) Elix & Hale, Mycotaxon **29**: 243. 1987.
Parmelia spumosa Asahina, J. Jpn. Bot. 26: 259. 1951.
Parmelina spumosa (Asahina) Hale, Phytologia 28: 483. 1974.
Hypotrachyna spumosa (Asahina) Krog & Swinscow, Lichenologist 19: 420. 1987.

Thallus closely adnate on bark, fragile; lobes sublinear, crowded, 0.5-2.0 mm wide; upper surface emaculate, densely pustulate-isidiate, the pustules bursting; medulla very pale yellow; lower surface black, rhizines simple or sparsely branched.

Chemistry: Cortex K+ yellow, medulla K−, C+ rose, KC+ red, P−; atranorin, gyrophoric acid, 5-O-methylhiascic acid and umbilicaric acid.

This widespread species is easily distinguished from the related species by the erupting but non-sorediate pustules.

Distribution: Pantropical at higher elevations. Taiwan (Hale 1976c).

Specimen examined. Taipei Co.: Mt. Tatungsan, about 600 m, *H. Shibuichi 8194*. Chiayi Co.: Tsutsonsan, Mt. Alisan, *SK 494*; en route from Susulu to Mt. Alisan, *SK 638*.

14. **PARMELIOPSIS** (Nyl.) Nyl.

Not. Sällsk. Fauna Fl. Fenn. Förh. **8**: 121. 1866.
(= FORAMINELLA S. L. F. Meyer, Mycologia 74: 596. 1982.)

Parmeliopsis is characterized by small foliose thalli, a pored epicortex, immersed pycnidia and large reniform spores (4-6 × 12-18 μm). It comprises five species, which show a similar distribution pattern as *Imshaugia*. One species is known in Taiwan. Key references: Hawksworth (1985); Meyer (1982).

Parmeliopsis ambigua (Wulfen) Nyl., Not. Sällsk. Fauna Fl. Fenn. Förh. **8**: 121. 1866.
Lichen ambiguus Wulfen in Jacquin, Collect. Bot. 4: 239. 1790.
Foraminella ambigua (Wulfen) S. L. F. Meyer, Mycologia 74: 597. 1982.

Thallus pale yellowish green, closely adnate, 2-5 cm broad; lobes narrow, 0.6-0.8 mm wide, linear; upper surface smooth with capitate, laminal soralia; lower surface black, with a narrow brown zone at the margins, moderately rhizinate.

Chemistry: Cortex and medulla K−, C−, P−; usnic and divaricatic acids.

The present species shows a boreal to arctic distribution as *Imshaugia aleurites*.

Distribution: Arctic-boreal and circumboreal. Europe, Siberia, Saghalien, North America, Australia, Asia—Japan, Thailand (Pooprang *et al.* 1999). New to Taiwan.

Specimen examined. Taichung Co.: Mt. Hsiaoshuesan, ca. 2900 m. *Lai s. n.* in 1998 (Lai).

15. **PARMOTREMA** A. Massal.

Atti. I. R. Ist. Veneto, Ⅲ, Ⅲ, 5: 248. 1860.

Parmotrema is a large, cosmopolitan genus, comprising about 220 species. It is characterized by large, moderately to loosely adnate thalli composed of broad lobes (usually more than 5 mm wide), a broad, naked marginal zone on the lower surface, a pored epicortex and a palisade-plectenchymatous upper cortex. In various species of this genus, the lobes can be ciliate or eciliate and apothecia are perforate or imperforate. Twenty five species are known in Taiwan. Key references: Hale (1965); Krog & Swinscow (1981); Louwhoff & Elix (1999).

Key to the species

1. Thallus isidiate or sorediate.
  2. Thallus with isidia.
    3. Lobe margins eciliate.
      4. Medulla C+ red, lecanoric acid present .... *P. tinctorum*
      4. Medulla C−, P+ red, protocetraric acid present .... *P. saccatilobum*
    3. Lobe margins ciliate.
      5. Isidia becoming soredia (soredia of isidial initials); medulla K−.
        6. Medulla P−, alectoronic acid present .... *P. mellisii*
        6. Medulla P+ brick red, protocetraric acid present ...... *P. subcorallinum*
      5. Isidia never becoming soredia; medulla K+ or K−.
        7. Medulla K− .... *P. nanfongense*
        7. Medulla K+.
          8. Medulla K+ yellow turning orange, stictic acid present; UV− ... *P. crinitum*
          8. Medulla K+ yellow turning red, salazinic acid present; UV+ bright yellow, containing lichexanthone.............................. *P. ultralucens*
  2. Thallus with soredia, the soredia never with isidia initials.
    9. Lobes lacking cilia or occasionally ciliate.
      10. Medulla C+ red, lecanoric acid present .... *P. austrosinense*
      10. Medulla C−.
        11. Medulla P+.
          12. Medulla K+ yellow turning red, salazinic acid present; soralia linear ... . *P. cristiferum*
          12. Medulla K−, protocetraric acid present; soralia borne on short marginal laciniae .... *P. dilatatum*
        11. Medulla P−.
          13. Soralia crescent-shaped; lobes narrower, 4-5 mm wide; medulla KC− .... *P. praesorediosum*
          13. Soralia never crescent-shaped; lobes broad, to 10 mm wide; medulla KC+ rose, alectoronic acid present .... *P. exquisitum*
    9. Lobes sparsely to densely ciliate.

14. Cilia very rare.
    15. Medulla P+ orange red, salazinic acid present; soralia linear .... *P. cristiferum*
    15. Medulla P+ brick red, protocetraric acid present; soralia borne on short marginal laciniae .... *P. robustum*
14. Cilia moderate to dense.
    16. Medulla white.
        17. Medulla K+.
            18. Norstictic acid absent .... *P. chinense*
            18. Norstictic acid present .... *P. parahypotropum*
        17. Medulla K−, KC+ red, constantly with alectoronic and α-collatolic acids.
            19. Upper surface distinctly maculate; apothecia perforate . *P. lobulascens*
            19. Upper surface not maculate; apothecia imperforate ... *P. rampoddense*
    16. Medulla deep or pale yellow, especially in the lower half.
        20. Pigment pale yellow; yellow pigment K− .... *P. permutatum*
        20. Pigment deep yellow; yellow pigment K+ wine red .... *P. sancti-angelii*
1. Thallus lacking isidia and soredia.
    21. Lower surface often ivory- to white-mottled along the margin.
        22. Upper surface emaculate or faintly maculate; medulla often orange yellow (K+ purple) in the lower half .... *P. subrugatum*
        22. Upper surface distinctly maculate; medulla white.
            23. Medulla P+ brick yellow; containing stictic acid .... *P. eciliatum*
            23. Medulla P−, containing alectoronic acid .... *P. argentinum*
    21. Lower surface uniformly black, except for dark brown naked zone near the apex.
        24. Medulla P−, containing alectoronic acid ....*P.corniculans*
        24. Medulla P+orange yellow or orange red.
            25. Medulla P+ orange yellow, containing salazinic acid .... *P. eurysacum*
            25. Medulla P+ orange red, containing protocetraric acid.
                26. Lobes broad and rotund, without conspicuous laciniae .... *P. overeemii*
                26. Lobes conspicuously laciniate .... *P. merrillii*

1. **Parmotrema argentinum** (Kremp.) Hale, Phytologia **28**: 334. 1974.
Parmelia argentina Kremp., Flora 61: 376. 1878.

Thallus loosely attached; lobes 7-12 mm wide, ciliate, cilia 1.5-3 mm; upper surface maculate, isidia and soredia lacking; lower surface black, mottled or white along the margins. Apothecia imperforate. Conidia rod-shaped.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ orange-red, P−;

atranorin and alectoronic acid.

The present species is distinctive in the obvious maculae, imperforate, normally ciliate apothecia, and the pale or white zone below at the margin.

Distribution: Tropical America – Argentina, Mexico, Honduras. New to Taiwan.

Specimens examined. Taitung Co.: Chokakurai, *H. Masuda s. n.* in 1936 (Herb. Asahina nos. *F-57* (dupl. in US) & *F-454*).

2. **Parmotrema austrosinense** (Zahlbr.) Hale, Phytologia **28**: 335. 1974.
Parmelia austrosinensis Zahlbr. in Handel-Mazzetti, Symb. Sin. 3: 192. 1930.
Parmelia hyporysalea (Vain.) Vain. var. *cinerascens* Vain., Bot. Mag. Tokyo 35: 47. 1921.

Thallus loosely attached; lobes 10-15 mm, eciliate, soralia marginal, sinuate; lower surface black, mottled to ivory or white in a broad zone along margins. Apothecia perforate.

Chemistry: Cortex K+ yellow, medulla K–, C+ rose-red, KC+ red, P–; atranorin and lecanoric acid.

Parmotrema austrosinense is widely distributed in the world, and especially common in savanna in Africa. Zahlbruckner (1933) and Asahina (1952) reported this species under the name *Parmelia hyporysalea* (Vain.) Vain. (= *Parmotrema andinum* (Müll. Arg.) Hale, the non-sorediate morph of *P. austrosinense*) from Taiwan.

Distribution: Pantropical. Taiwan (Asahina 1952 as *Parmelia hyporysalea*).

Specimens examined. Hsinchu Co.: Shenchiaoshi, *SK 3060*. Nantou: Lusan, elevation about 1400 m, *H. Shibuichi 7876*; Lakeside of Bihu, Wushe, Jenaihsiang, elevation about 1050 m, *H. Shibuichi 7059*; Chitou, *YA s. n.* in 1933; *SK 1349*. Kaohsiung Co.: Shanping, elevation about 750 m, *SK 2749*.

3. **Parmotrema chinense** (Osbeck) Hale & Ahti, Taxon **35**: 133. 1986.
Lichen chinensis Osbeck, Ostindisk resa 221. 1757.
Parmelia perlata (Huds.) Ach., Meth. Lich. 216. 1803.
Parmotrema perlatum (Huds.) M. Choisy, Bull. Mens. Soc. Linn. Lyon 21: 174. 1952.
Parmelia trichotera Hue, J. de Bot. 12: 245. 1898.
Parmotrema trichoterum (Hue) M. Choisy, Bull. Mens. Soc. Linn. Lyon 21: 175. 1952.

Thallus adnate to loosely adnate; lobes 8-15 mm wide, moderately ciliate, cilia 0.3-2 mm long; soralia submarginal; lower surface black, rhizines moderately dense. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning orange, C–, KC –, P+ pale orange yellow; atranorin, stictic acid and constictic acid.

The present species is easily distinguished from related species by its revolute, sorediate margins. According to Asahina (1952), the specimen reported as *Parmelia perlata* by Zahlbruckner (1933) is identified as *Parmelia neglecta* (= *Parmotrema praesorediosum*).

Distribution: Pantemperate on both hemispheres. New to Taiwan.

Specimens examined. Ilan Co.: En route from Suyen to Mt. Nanhutasan, Hopin, elevation about 2100 m, *K. Yoshida 9836*. Hwalien Co.: Mt. Hohuansan, elevation about 3200 m, *H. Shibuichi 7990*.

4. **Parmotrema corniculans** (Nyl.) Hale, Phytologia **28**: 335, 1974.
Parmelia corniculans Nyl., Flora 68: 607. 1885.

Thallus loosely adnate; lobes rotund, 10-13 mm wide, ±dentate-laciniate with age at the margins, ciliate, cilia up to 6 mm long; upper surface emaculate, soredia and isidia lacking; lower surface black and sparsely rhizinate, with a bare broad zone along the margins. Apothecia stalked, dentate and ciliate at the margins; disc perforate, spores 16-18 × 30-35 μm.

Chemistry: Cortex K+ yellow, medulla K−, KC+ reddish orange, C−, P−; atranorin, alectoronic acid, α-collatolic acid and skyrin.

The present species is restricted to southeastern Asia and is separated geographically from comparable species containing alectoronic acid in Africa and America. It resembles *P. merrillii* in having similar laciniae, but the latter species contains protocetraric acid and has imperforate apothecia. The specimens cited below were identified by Dr. Mason E. Hale in 1978.

Distribution: The Philippines, Java, Laos, Papua New Guinea and Thailand (Pooprang *et al.* 1999). New to Taiwan.

Specimens examined. Taoyuen Co.: Mt. Lalasan, Paling, 1600 m alt., *Lai 9413*, *9414* (Lai).

5. **Parmotrema crinitum** (Ach.) M. Choisy, Bull. Mens. Soc. Linn. Lyon **21**: 175. 1952.
Parmelia crinita Ach., Syn. Lich. 196. 1814.
Parmelia proboscidea Taylor in Mackay, Fl. Hibern. 143. 1836.

Thallus adnate to loosely attached; lobes 6-12 mm, ciliate, cilia 1-2 mm long; upper surface white-maculate, isidiate, the isidia laminal and marginal, often ciliate; lower surface black, rhizines moderate, simple to squarrose. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning orange, C−, KC−, P+ orange yellow; atranorin, stictic acid and constictic acid.

Parmotrema eciliatum (Nyl.) Hale possibly represents the parent morph of the sorediate *P. chinense* and the isidiate *P. crinitum*.

Distribution: Widely distributed in tropical to temperate regions. Taiwan (Zahlbruckner 1933, as *Parmelia proboscidea*).

Specimens examined. Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 743* (dupl. in US); en route from Suyen to Mt. Nanhutasan, Hopin, elevation about 2300 m, *K. Yoshida 9838*, the same locality, elevation about 2100 m, *K. Yoshida 9837*, the same locality, elevation about 2250 m, *K. Yoshida 9834*. Nantou Co.: Chitou, *YA s. n.* in 1933, *YA F-458, SK 1348*, *1351*. Chiayi Co: Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 135* (dupl. in US), *140*; Mt. Yusan, *Stenroos 3322b* (H). Kaohsiung Co.: Shanping, elevation about 750 m, *SK 2715*; Shunsan, Mt. Nanfong, elevation about 1200 m, *SK 2948*. Taitung Co: Mt. Lachialachiaerh, elevation about 1800 m, *SK 2480*.

6. **Parmotrema cristiferum** (Taylor) Hale, Phytologia **28**: 335. 1974.

Parmelia cristifera Taylor, London J. Bot. 6: 165. 1847.

Thallus loosely attached; lobes 12-20 mm wide, eciliate or occasionally ciliate, sorediate, soralia linear; lower surface black, rhizines rather dense. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, KC−, P+ orange red; atranorin, salazinic acid and consalazinic acid (minor).

The present species resembles *Parmotrema dilatatum* from which it is distinguished by the presence of salazinic acid rather than protocetraric acid. Both species have marginally sorediate lobes. Hale (1965) considered this species to be without cilia, however, it is occasionally short-ciliate, and is more often ciliate than *P. dilatatum*.

Distribution: Pantropical. Taiwan (Hale 1965).

Exsiccata examined. S. Kurokawa: Lich. Rar. Crit. Exs., no. 25 (distributed as *Parmelia cristifera*).

Specimens examined. Nantou Co.: Lakeside of Sun Moon Lake, *SK 1308*; Chitou, *YA s. n.* in 1933; Lienhuachih, *YA*, *F-76*, *Y. Saito s. n.*; Kuwarus, *E. Ochiai* (Herb. Asahina no. *F-51*). Hwalien Co.: Taroko, *M. Ogata s. n.* in 1935. Taitung Co.: Antung Pass, elevation 400-995 m, *SK 2659*, *2660*; Mt. Wunitoparu, elevation about 1900 m, *SK 2566*, Chinsueiin Pass, elevation 400-1200 m, *SK 2988*; Shinsuiei, *T. Masuda s. n.* in 1934; Chokakurai, *T. Masuda s. n.* in 1936. Kaohsiung Co.: Sanping, elevation about 750 m, *SK 2713*, *2714*, *2718*, *2721*, *2724*; Mt. Nanfong, *Chuang 3390* (Lai). Pingtung Co.: Kural, elevation 250 m, *SK 1488*, *1490*; Mt. Nanjensan, Manchou, elevation about 150 m, *K. Yoshida 9523*; Kusukusu, *SK 1590* (dupl. in US).

7. **Parmotrema dilatatum** (Vain.) Hale, Phytologia **28**: 335. 1974.

Parmelia dilatata Vain., Acta Soc. Fauna Fl. Fenn. 7 (7): 33. 1890.

Parmelia affluens Hale, Phytologia 22: 141. 1971.

Parmotrema affluens (Hale) Hale, Phytologia 28: 334. 1974.

Thallus loosely adnate; lobes 10-15 mm wide, eciliate or extremely rarely ciliate, sorediate, soralia produced on short marginal laciniae; lower surface black. Apothecia imperorate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ reddish, P+ brick red; atranorin, usnic acid (trace), protocetraric acid, echinocarpic acid, secalonic acid A and other pigments.

The present species closely resembles *Parmotrema cristiferum* from which it is easily distinguished by the production of protocetraric acid rather than salazinic acid.

Distribution: Pantropical. New to Taiwan.

Specimens examined. Pingtung Co.: Soka, elevation about 450 m, on *Quercus championi*, *SK 2959*.

8. **Parmotrema eciliatum** (Nyl.) Hale, Phytologia **28**: 336. 1974.

Parmelia crinita Ach. var. *eciliata* Nyl., Flora 52: 291. 1872.

Parmelia eciliata (Nyl.) Nyl. in Fournier, Mex. Pl. 3. 1872.

Thallus loosely adnate, lobes 5-8 mm wide, ciliate, cilia 1-2.5 mm long; isidia and soredia absent; lower surface black, tan or white mottled along the margin. Apothecia imperforate. Conidia rod-shaped.

Chemistry: Cortex K+ yellow, medulla K+ yellow, C−, KC−, P+ pale orange yellow; atranorin, stictic acid and constictic acid (trace).

Parmotrema eciliatum superficially resembles *P. crinitum*, which has isidia on the upper surface as well as along the lobe margins.

Distribution: West Indies, Central and South America, South Africa, Australia. Japan, Taiwan (Kurokawa 1968b).

Specimens examined. Ilan Co.: Mt. Nanhutasan, elevation 2400-2600 m, *SK 1037*; en route from Suyen to Nanhutasan, Hopin, elevation about 2750 m, *K. Yoshida 9841*. Hwalien Co.: Mt. Hohuansan, Hsiulinhsiang, elevation about 3100 m, *H. Shibuichi 7893*; between Tayuling and Mt. Hohuansan, *Koponen 18201* (H). Taitung Co.: Bayu Lake, elevation about 2200 m, *SK 2387*; Mt. Lachialachiaerh, elevation about 1800 m, *SK 2481*, *2482*, *2484*.

9. **Parmotrema eurysacum** (Hue) Hale, Phytologia **28**: 336. 1974.
Parmelia eurysaca Hue, Nouv. Arch. Mus. Paris, ser. 4, 1: 194. 1899.

Thallus loosely adnate, coriaceous; lobes rotund, 10-14 mm wide, dentate-laciniate, ciliate; isidia and soredia lacking; lower surface black. Apothecia substipitate, perforate.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, C−, KC−, P+ pale orange red; atranorin and salazinic acid.

The present species is characterized by the pycnidiate marginal laciniae, and is the only ciliate species with salazinic acid which lacks soredia or isidia.

Distribution: Mexico and adjacent U.S.A., East Africa, Australia. New to Taiwan.

Specimen examined. Pingtung Co.: Kenting, Hengchun, elevation about 300 m, *K. Yoshida 9537*.

10. **Parmotrema exquisitum** (Kurok.) DePriest & B. Hale, Mycotaxon **67**: 204. 1998.
Parmelia exquisita Kurok., Bull. Nat. Sci. Mus. Tokyo, ser. B, 13: 11, 1987.

Thallus loosely adnate; lobes 5-12 mm wide, eciliate; upper surface emaculate, soredia marginal and laminal; lower surface often subreticulately rugose.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ rose, P−; atranorin, alectoronic acid and α-collatolic acid.

The present species resembles *P. rampoddense*, from which it is distinguished by lacking cilia and skyrin in the medulla. *P. exquisitum* is also easily confused with *P. mellisii*, which is ciliate and forms granular soredia originated from isidia along the lobe margins. It was first described from Uruguay in S. America (Kurokawa 1987), but now the range is extended to Asia.

Distribution: Uruguay. New to Taiwan.

Specimen examined. Taichung Co.: Mt. Pasiensan, *Lai 3117* (Lai, US).

11. **Parmotrema lobulascens** (J. Steiner) Hale, Phytologia **28**: 337. 1974.
Parmelia lobulascens J. Steiner, Verh. Zool.–Bot. Ges. Wien 53: 234. 1963.
Parmelia pseudonilgherrensis Asahina, J. Jpn. Bot. 29: 370. 1954.
Parmotrema pseudonilgherrense (Asahina) Hale, Mycotaxon 5: 441. 1977.

Thallus loosely attached; lobes 5-15 mm wide, ciliate, cilia 0.2-5 mm long;

upper surface distinctly maculate, soralia marginal; lower surface black, rhizines coarse. Apothecia perforate. Conidia filiform.

Chemistry: Cortex K+ yellow, Medulla K−, C+ rose, KC+ brick red, P−; atranorin, gyrophoric acid (+or−), alectoronic acid and α-collatolic acid (+or −).

Krog & Swinscow (1981) reduced *Parmelia pseudonilgherrensis* Asahina to a synonym of *P. lobulascens* basing this on their identical chemistry. The present species is distinguished by the markedly maculate upper surface and conspicuously developed lobules, as well as in the soredia which form elongate soralia.

Distribution: Africa, Korea. New to Taiwan.

Specimens examined. Chiayi Co.: Chiensan, Mt. Morrison, elevation 3100-3300 m, *SK 252*; Tsutsonsan, Mt. Alisan, elevation 2300-2900 m, *SK 132*.

12. **Parmotrema mellissii** (C. W. Dodge) Hale, Phytologia **28**: 337. 1974.
Parmelia mellissii C. W. Dodge, Ann. Mo. Bot. Gard. 46: 134. 1959.
Parmelia allardii Hale, Bryologist 62: 123. 1959.

Thallus loosely adnate, membranaceous; lobes 6-12 mm wide, ciliate, cilia 1-5 mm long; upper surface isidiate-sorediate along the margins; medulla white, often yellow pigmented in the lower half; lower surface black, rhizines ±dense. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ red or orange red, P −, pigmented medulla K+ purple; atranorin, alectoronic acid, α-collatolic acid and skyrin.

This species is characterized by ciliate, lobulate-dissected margins, which ultimately become sorediate and have ciliate isidia. It may be confused with *P. rampoddense*, in which soralia are linear or capitate on revolute lobe apices and the soredia are farinose. *P. mellissii* is a widely distributed weedy species in temperate and subtropical regions in the world, except for Europe.

Distribution: Pantropical, extending northward to temperate U.S.A. and Japan. Taiwan (Wang-Yang & Lai 1973).

Specimens examined. Taipei Co.: Tatunsan, elevation about 600 m, *H. Shibuichi 8193*; Hsinpeitou, *T. Suzuki s. n.* (Herb. Y. Asahina no. *10992*). Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 745*. Nantou Co.: Chitou, *YA F-451*, *T. Masuda s. n.* in 1933, *YA s. n.* in 1933, *SK 1350*, *1343* (dupl. in US), *1344*, *1345*; Yuchih, vicinity of Sun Moon Lake, elevation about 700 m, *H. Shibuichi 7813*. Chiayi Co.: Toroyen, Mt. Alisan, *YA F-58*, *F-69*; en route from Funchifu to Chalapin, elevation 1300-1600 m, *SK 553* (dupl. in US); en route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 612*, *614*; Tsutsonsan, Mt. Alisan, elevation 2200-2600 m, *SK 482*, *484* (dupl. in US); Tsutsonsan, Mt. Alisan, *SK 138*. Kaohsiung Co.: Sanping, elevation about 750 m, *SK 2711*, *2712*. Taitung Co.: Antung Paso, elevation about 400-995 m, *SK 2661*; Bayu Lake, elevation about 2200 m, *SK 2384*, *2386*; Chinsueiin Pass, elevation 1200-1600 m, *SK 3013*, *3014*, 3015; Chokakurai, *T. Masuda s. n.* in 1936.

13. **Parmotrema merrillii** (Vain.) Hale, Phytologia **28**: 337. 1974.
Parmelia merrillii Vain., Phil. J. Sci. 4: 658. 1909.

Thallus loosely adnate; lobes 10-15(-18) mm wide, dentate-laciniate especially on older lobes, lacking cilia or ciliate only in axils, cilia 1-1.5 mm long; soredia and isidia lacking; lower surface black, rhizines sparse. Apothecia dentate-laciniate and ciliate on the margin; disc imperforate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ pink, P+ brick red; atranorin and protocetraric acid.

The present species has long, narrow laciniae on the lobes and often on the exciple of the apothecia. It resembles *P. corniculans*, another Asian species, which differs in containing alectoronic acid and in having perforate apothecia.

Distribution: The Philippines, Sumatra, Java, Bolivia, Taiwan (Hale 1965).

Specimen examined. Taitung Co.: Chokakurai, *H. Masuda* (Herb. Asahina, no. *F-546*).

14. **Parmotrema nanfongense** (Kurok.) DePriest & B. Hale, Mycotaxon **67**: 204. 1998.

Parmelia nanfongensis Kurok., Bull. Nat. Sci. Mus. Ser. B, 13: 12. 1987

Thallus corticolous, loosely adnate, coriaceous, 8-12 cm broad; lobes 5-10 mm wide, ciliate, cilia moderate to dense, rarely divided, 1-4 mm long; upper surface emaculate, partly densely isidiate, isidia cylindrical or coralloid, often ciliate; medulla white; lower surface black, often white-mottled at marginal zone, sparsely rhizinate, rhizines simple, 1-2 mm long. Apothecia not seen.

Chemistry: Cortex K+ yellowish, medulla K−, C−, KC+ rose, P−; atranorin, alectoronic acid and α-collatolic acid.

Parmotrema nanfongense produces alectoronic and α-collatolic acids and has an emaculate upper surface as in *P. mellissii*. The latter species has marginal or submarginal isidial soredia or granular soredia, while *P. nanfongense* is characterized by the cylindrical or coralloid isidia never becoming sorediate at the tips. It has long been considered to be endemic to Taiwan. However, Louwhoff & Elix (1999) recently reported it from Papua New Guinea.

Distribution: Papua New Guinea and Taiwan (Kurokawa 1987).

Specimens examined. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2787* (holotype of *Parmelia nanfongensis*.), *2792*; elevation about 1200 m, *SK 2922*.

15. **Parmotrema overeemii** (Zahlbr.) Elix, Austral. Lichenol. **42**: 23. 1998

Parmelia overeemii Zahlbr., Ann. Crypt. Exot. 1: 204. 1928.

Thallus membranaceous, loosely adnate; lobes 10-18 mm wide, ciliate, cilia common, short, 0.5-0.8 mm; upper surface emaculate, isidia and soredia lacking; lower surface black, rhizines sparse. Apothecia imperforate.

Chemistry: Cortex K+ yellow; medulla K−, C−, KC+ pink, P+ orange red; atranorin and protocetraric acid.

Asahina (1952) and Hale (1965) reported the occurrence of the present species in Taiwan under the name *Parmelia zollingeri* (= *Parmotrema zollingeri* (Hepp) Hale). According to Elix (1998), however, *P. zollingeri* contains mainly succinprotocetraric and fumarprotocetraric acids, whereas protocetraric acid is a main secondary product in the present species. Thus, the specimens cited below are identified as *P. overeemii*.

Distribution: Australia, Papua New Guinea, East Africa, Indonesia, Thailand (Pooprang *et al.* 1999) and Tonga. New to Taiwan.

Specimens examined. Taitung Co.: Lanyu Island, *G. Nakahara s. n.* in 1906. Pintung Co.:

Kural, *YA s. n.* in 1934 (dupl. in US); the same locality, *YA s. n.* in 1933; the same locality , elevation 1000 m, *K. Komura s. n.* in 1937; the same locality, elevation 250 m, *SK 1491*, *1492* (dupl. in US), 1493 (dupl. in US), *1494*; Hengchun, elevation about 20 m, *K. Yoshida 9450*; Kenting, Hengchun, elevation 150 m, *K. Yoshida 9532.*

16. **Pamotrema parahypotropum** (W. L. Culb.) Hale, Phytologia **28**: 338. 1974.
Parmelia parahypotropa W. L. Culb., The Bryologist 76: 29. 1973.

Thallus loosely adnate; lobes 1-4 mm wide, ciliate, cilia 1-2 mm long; soralia marginal; lower surface black, white-mottled near the margin. Apothecia not seen.

Chemistry: Atranorin, norstictic acid, salazinic acid and galbinic acid (T. Kurokawa & Yoshimura 1979).

The present species is characterized by the marginal soralia and subascending lobes, and by the production of norstictic, salazinic and galbinic acids in addition to atranorin. Although Hale (1965) included Taiwan in the distribution range of *Parmelia hypotropa* Nyl., the cited specimen (Nantou County: Chitou, *Asahina 3411*) is actually *Parmotrema parahypotropum* as pointed out by Culberson (1973). Zahlbruckner's (1933) report of *Parmelia hypotropa* in Taiwan seems doubtful.

Distribution: Taiwan (W. Culberson 1973), Japan (Ryukyu Islands, Bonin Islands) (Kurokawa 1984, T. Kurokawa & Yoshimura 1979), northeastern Australia and East Africa (Kenya).

Specimens examined. Nantou Co.: Chitou, *YA 3411* (dupl. in US). Pingtung Co.: Kural, elevation 250 m, *SK 1487* (holotype of *Parmelia parahypotropa* W. L. Culb. in TNS, isotype in US); Kenting, Hengchun, elevation about 300 m, *K. Yoshida 9524.*

17. **Parmotrema permutatum** (Stirt.) Hale, Mycotaxon **1**: 113. 1974.
Parmelia permutata Stirt., Scot. Nat. 4: 252.1877-78.

Thallus loosely adnate, coriaceous; lobes 8-15 mm wide, ciliate, cilia conspicuous, 2-4.5 mm long; soralia marginal, linear, eroding; medulla pale yellow only in the lower half; lower surface black, often mottled or white along the margins, rhizines sparse. Apothecia not seen.

Chemistry: Cortex K+ yellow, medulla K−, C+ red, KC+ red, P−; atranorin, gyrophoric acid, lecanoric acid (trace), eumitrin E (minor), eumitrin Q (minor) and other related pigments.

The present species differs from other *Parmotrema* in containing pale yellow pigments that occur in the lower half of the medulla. It has conspicuous cilia and distinct marginal soralia. *P. sancti-angeli* may also have a pigmented medulla, but this is due to skyrin, a K+ purple pigment.

Distribution: Pantropical. New to Taiwan.

Specimens examined. Nantou Co.: Chitou, *SK 1355*; Yuchih, near Sun Moon Lake, elevation about 750 m, *K. Yoshida 7076*. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2786*, *2788.*

18. **Parmotrema praesorediosum** (Nyl.) Hale, Phytologia **28**: 338. 1974.
Parmelia praesorediosa Nyl., Sert. Lich. Trop. Lubuan Singapore 18. 1891.
Parmelia neglecta Asahina, J. Jpn. Bot. 17: 71. 1941.
Parmelia luzonensis Räsänen, Ann. Bot. Soc. Zool. Bot. Vanamo 3: 78. 1948.

Thallus adnate, lobes 4-5 mm wide, eciliate, sorediate, soralia crescent-shaped;

lower surface black, often mottled or white along the margins. Apothecia imperforate. Conidia sublageniform.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC−, P−; atranorin, protopraesorediosic acid and praesorediosic acid.

The present species is corticolous and saxicolous and occurs at low elevations as a weedy species, very often growing on planted or cultivated trees. It is characterized by the eciliate margins of sorediate, often sinuous lobes and the crescent-shaped soralia. Superficially it may be confused with *P. cristiferum* or *P. dilatatum*, but the medulla is P−, whereas the medulla is P+ in the latter two species. Zahlbruckner (1933) reported *Parmelia perlata* from Taiwan, but according to Asahina (1952), it may concern *P. neglecta* (= *Parmotrema praesorediosum*).

Distribution: Pantropical. Taiwan (Asahina 1941, 1952 as *Parmelia neglecta*).

Exsiccata examined. S. Kurokawa, Lich. Rar. Crit. Exs., nos. 32, 79 (distributed as *Parmelia praesorediosa*).

Specimens examined. Taipei Co.: En route from Keelung to Tamsui, *SK 1283* (dupl. in US). Nantou Co.: En route from Chusan to Chitou, elevation 500-1000 m, *SK 1323*; Raisha, *YA F-51* (holotype of *Parmelia neglecta* Asahina). Kaohsiung Co.: En route from Liukuei to Sanping, elevation 400-750 m, *SK 2691*; Sanping, elevation about 750 m, *SK 2716*. Taitung Co.: Antung Pass, elevation 400-995 m, *SK 2658*; vicinity of Pasoan, elevation about 50 m, *SK 2637*; Lanyu Island, *S. Sasaki s. n.* in 1926; Lanyu, elevation about 150 m, *K. Yoshida 9447*; elevation about 20 m, *K. Yoshida 9451*.

19. **Parmotrema rampoddense** (Nyl.) Hale, Phytologia **28**: 338. 1974.
Parmelia rampoddensis Nyl., Acta Soc. Sci. Fenn. 26 (10): 7. 1900.

Thallus loosely attached; lobes 10-20 mm wide, ciliate, cilia 3-6 mm long; upper surface emaculate, soralia marginal; medulla white, sometimes yellow-orange in part; lower surface black, often mottled or white along the margins, rhizines sparse to moderate. Apothecia imperforate. Conidia rod-shaped.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ red, P−, pigmented medulla K+ purple; atranorin, alectoronic acid, α-collatolic acid and skyrin.

The present species may be confused with *P. mellissii*, since these two species produce alectoronic acid and have moderate to dense cilia. However, the latter species has fragile isidia, isidial soredia, or granular soredia, while *P. rampoddense* has farinose soredia.

Distribution: Pantropical. U.S.A., Haiti, Colombia, Cameroons, India, Australia, New Guinea, E. Himalaya, Nepal, Japan, Ethiopia.Taiwan (Hale 1965).

Specimens examined. Taipei Co.: Huangtitien, *Lai 1976* (Lai). Hsinchu Co.: Mt. Kakubanyama, *M. Ogata s. n.* in 1924. Ilan Co.: En route from Suyen to Mt Nanhutasan, Hopin, elevation about 2650 m, *K. Yoshida 9833*. Nantou Co.: Chitou, *YA s. n.* in 1933, *SK 1340* (dupl. in US), *1346*; Sun Moon Lake, *YA F-459*; lakeside of Sun Moon Lake, *SK 1309*; Wushe, elevation about 1100 m, *H. Shibuichi 7853*; Lienhuachih, *YA F-56*, *F-55*, *YA s. n.* in 1925. Chiayi Co.: Mt. Alisan, Toroyen, *YA s. n.* in 1925; elevation 2200 m *SK 36*, *570*. Kaohsiung Co.: En route from Liukuei to Sanping, elevation 400-750 m, *SK 2692*; Sanping, elevation about 750 m, *SK 2722*, *2725*, *2710*, *2720*; Mt. Nanfong, elevation 800-1300 m, *SK 2794*, *2795*, *2880*, *2785*, *2789*, *2796*, *2797*, *2799*; elevation 1300-1500 m, *SK 2903*; Shunsan, Mt. Nanfong, elevation about 1200 m, *SK 2923*. Taitung Co.: Mt. Lachialachiaerh, elevation about 1800 m, *SK 2483*; Chokakurai, *H. Masuda s. n.* in 1936. Hwalien Co.: Hoping, *Lai 2031*.

20. **Parmotrema robustum** (Degel.) Hale, Phytologia **28**: 338. 1974.
Parmelia robusta Degel. Goth. Vet. Vitterh. Samh. Handl. ser. B, 7: 33. 1941.

Thallus loosely adnate; lobes 10-15 mm wide, sparsely ciliate; upper surface emaculate, sorediate along the margin; lower surface black, rhizines sparse. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC−, P+ orange red; atranorin, protocetraric acid, virensic acid (trace) and fatty acids (+ or −).

The present species is easily confused with *P. dilatatum*, because these species are sorediate and produce protocetraric acid in the medulla. However, it is clearly distinguished from the letter by the presence of sparse cilia along the lobe margins.

Distribution: Pantropical. New to Taiwan.

Specimens examined. Ilan Co.: Piyanan, elevation 1100-1300 m, *SK 742*. Taitung Co.: Mt. Wunitoparu, elevation about 1900 m, *SK 2567* (dupl. in TUR).

21. **Parmotrema saccatilobum** (Taylor) Hale, Phytologia **28**: 339. 1974.
Parmelia saccatiloba Tayor., London J. Bot. 6: 174. 1847.
Parmelia tinctorum var. *inactiva* Zahlbr., Denschr. Akad. Wiss. Naturw. Wien 81: 271. 1908.
Parmelia inactiva (Zahlbr.) Vain., Bot. Mag. Tokyo 35: 47. 1921.

Thallus loosely attached; lobes 5-10(-15) mm wide, eciliate; upper surface emaculate, isidiate, isidia cylindrical; lower surface black, rhizines sparse. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ reddish, P+ orange red; atranorin and protocetraric acid.

Parmotrema saccatilobum resembles *P. subcorallinum* in thallus colour and presence of isidia, and is distinguished by its eciliate lobes.

Distribution: South Pacific region, Australia, India and Singapore. Taiwan (Zahlbruckner 1933, as *Parmelia tinctorum* var. *inactiva*; Kurokawa 1985).

Specimens examined. Pintung Co.: 5 km southeast of Soka, elevation about 450 m, *SK 3025*; Kural, elevation 250 m, *SK 1482* (dupl. in US), *1483* (dupl. in US), *1484* (dupl. in US), *1485*, *1486* (dupl. in US), *1489*; Mt. Nanjensan, Manchou, elevation about 150 m, *K. Yoshida 9540*, *9539*.

22. **Parmotrema sancti-angelii** (Lynge) Hale, Phytologia **28**: 339. 1974.
Parmelia sancti-angelii Lynge, Ark. Bot. 13: 35. 1914.
Parmelia pseudohyporysalea Asahina in Kihara, Fauna Fl. Nepal Himalaya 54. 1955.

Thallus loosely attached; lobes 8-15 mm wide, ciliate, cilia 2-4 mm long; soralia mainly marginal, linear; medulla white or yellow-orange (K+ purple) in part; lower surface black, rhizines sparse. Apothecia imperforate. Conidia weakly sublageniform.

Chemistry: Cortex K+ yellow, medulla K−, C+ red, KC+ red, P−; atranorin, gyrophoric acid and skyrin.

The present species is characterized by marginal, sometimes submarginal soralia and by the production of gyrophoric acid in the medulla. It resembles *P. permutatum*, from which it is distinguished by more rotund lobes, linear soralia and by the lack of medullary pigments or the presence of skyrin, if pigmented.

Distribution: Pantropical. Taiwan (Wang-Yang & Lai 1973).

Specimens examined. Taichung Co.: Mt. Pasiensan, *Lai 3117* (Lai). Nantou Co.: Lakeside of Sun Moon Lake, *SK 1307*, *1311*, *1312* (dupl. in US). Chiayi Co.: En route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 613*. Kaohsiung Co.: Sanping, elevation about 750 m, *SK 2717*, *2723*.

23. **Parmotrema subcorallinum** (Hale) Hale, Phytologia **28**: 339. 1974.
Parmelia subcorallina Hale, J. Jpn. Bot. 37: 345. 1962.

Thallus loosely adnate, membranaceous; lobes 8-15 mm wide, ciliate, cilia 1.5-5 mm long; upper surface (±) faintly maculate, isidiate, isidia often apically ciliate, fragile and becoming granulate-isidiate; lower surface black, rhizines moderate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ reddish, P+ orange red; atranorin, protocetraric acid and protolichesterinic acid.

The present species is distinctive in having isidiate-dissected lobe margins and granular isidia, which are often ciliate. It resembles *P. crinitum*, which has cylindrical isidia and produces stictic acid instead of protocetraric acid.

Distribution: Papua New Guinea (Louwhoff & Elix 1999), Java, Mauritius, Taiwan (Hale 1962).

Specimens examined. Nantou Co.: Lakeside of Sun Moon Lake, *SK 1306-b*; Sun Moon Lake, *YA F-457*; Chitou, *YA s. n.* in 1933, *SK 1340-a*, *1341*, *1342*, *YA 3312* (holotype of *Parmelia subcorallina* Hale in TNS, isotype in US); Lienhuachih, *YA s. n.* in 1925. Nantou Co.: Chitou, *SK 1340-a* (dupl. in US), *1341*, *1342*. Chiayi Co.: Mt Alisan, *YA F-452*. Taitung Co.: Chokakurai, *T. Masuda s. n.* in 1936. Kaohsiung Co.: Mt. Nanfong, elevation 800-1300 m, *SK 2793*; Shunsan, Mt. Nanfong, elevation about 1200 m, *SK 2920*.

24. **Parmotrema subrugatum** (Kremp.) Hale, Phytologia **28**: 334. 1974.
Parmelia subrugata Kremp., Verh. Zool. Bot. Gesell. Wien 18: 320. 1868.
Parmelia sinensis Hue, Nouv. Arch. Mus. Paris, ser. 4, 1: 187. 1899.

Thallus loosely attached; lobes 7-15 mm wide, dissected-laciniate, ciliate, cilia 1-3 mm long; upper surface ± weakly maculate, lacking isidia and soredia; medulla white, usually orange yellow in the lower half; lower surface black, ivory or mottled near the margin, rhizines sparse. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC+ red, P−; medulla often pigmented, K+ purple; atranorin, alectoronic acid, α-collatolic acid and skyrin.

The present species has short-laciniate, suberect lobes, distinct maculae on the upper surface, and a pale zone below. It is also characterized by containing alectoronic acid and imperforate apothecia.

Distribution: Australia, Africa, Brazil, Haiti, Mexico, China (Hale 1965), Papua New Guinea (Streiman 1990). New to Taiwan.

Specimens examined. Kaohsiung Co.: Mt. Nanfong, elevation 1300-1500 m, *SK 2909*; Shunsan, Mt. Nanfong, elevation about 1200 m, *SK 2921*.

25. **Parmotrema tinctorum** (Nyl.) Hale, Phytologia **28**: 339. 1974.
Parmelia tinctorum Nyl., Flora 55: 547. 1872.
Parmelia pseudotinctorum des Abb., Bull. Inst. Fr. Afr. Noire A, 13: 973. 1951.
Parmotrema pseudotinctorum (des Abb.) Hale, Phytologia 28: 338. 1974.

Thallus loosely adnate; lobes 10-15 mm wide, eciliate, isidiate, the isidia cylindrical, simple or branched; lower surface black, rhizines sparse, coarse. Apothecia imperforate.

Chemistry: Cortex K+ yellow, medulla K−, C+ red, KC+ red, P−; atranorin and lecanoric acid.

Parmotrema tinctorum is a cosmopolitan, weedy species easily identified by the simple or coralloid isidia as well as the C+ brilliant red reaction in the medulla, the large-lobed thallus and a broad erhizinate zone along the margins on the lower surface. The isidia are rather variable.

Distribution: Pantropical and temperate regions. Taiwan (Zahlbruckner 1933).

Specimens examined. Taipei Co.: En route from Keelung to Tamsui, *SK 1280*, *1281*; Neihu, *Lai 6750*, *6751* (Lai). Taoyuen Co.: Wulai to Paling, *Lai 6922* (Lai). Hsinchu Co.: Shenchaoshi, *SK 3059*. Nantou Co.: Chitou, *YA s. n.* in 1933, *Lai 2253*, *2254*, *10501* (Lai), *T. Masuda s. n.* in 1933; en route from Chusan to Chitou, elevation 500-1000 m, *SK 1321* (dupl. in US); Lusan, elevation about 1100 m, *H. Shibuichi 7874*; Sun Moon Lake, *YA s. n.* in 1933; lakeside of Sun Moon Lake, *SK 1304*, *1305*. Chiayi Co.: Toroyen, Mt. Alisan, *s. c. & s. n.* in 1925; en route from Funchifu to Chalapin, elevation 1300-1600 m, *SK 551*; en route from Susulu to Funchifu, elevation 1700-2000 m, *SK 524*, *528*, *529*; en route from Susulu to Mt. Alisan, elevation 2000-2200 m, *SK 610* (dupl. in US); Lienhuachih, *s. c. & s. n.* in 1925. Taitung Co.: Chinsueiin Pass, elevation 400-1200 m, *SK 2987*. Kaohsiung Co.: En route from Liukuei to Sanping, elevation 400-750 m, *SK 2693*; Sanping, elevation about 750 m, *SK 2719*; Mt. Nanfong, elevation 800-1300 m, *SK 2798*. Pingtung Co.: Kenting, Hengchun, elevation about 250 m, *K. Yoshida 9526*, *9527*, *9528*, *9529*; Kural, elevation 250 m, *SK 1491-a*, *1521*.

26. **Parmotrema ultralucens** (Krog) Hale, Mycotaxon **1**: 108. 1974.
Parmelia ultralucens Krog, The Bryologist 77: 253. 1974.

Thallus loosely adnate; lobes 8-15 mm wide, margins crenate and isidiate-dissected, ciliate, cilia 2 mm long; upper surface dull, sometimes pruinose, isidiate, isidia cylindrical, simple or coralloid, often ciliate; lower surface black, moderately rhizinate, with a bare, broad, brown marginal zone. Apothecia rare, disc imperforate.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning red, P+ orange, C−, KC−, UV+ bright yellow; atranorin, salazinic acid and lichexanthone.

The present species is characterized by having isidia and cilia and producing salazinic acid and lichexanthone.

Distribution: Pantropical to temperate (Krog 1974, with a map of world distribution). New to Taiwan.

Specimens examined. Taipei Co.: Tamsui, *U. Faurie 85* (KYO). Taichung Co.: Lisan, *SK 877*. Kaohsiung Co.: Sanping, elevation about 750 m, *SK 2709*.

UNCERTAIN SPECIES

Parmotrema nilgherrense (Nyl.) Hale, Phytologia **28**: 338. 1974.
Parmelia nilgherrensis Nyl., Flora 52: 291. 1869.
Parmelia yunnana Hue, Nouv. Arch. Mus. Paris, ser. 4, 1: 186. 1899.
Parmelia siamensis Vain., Ann. Soc. Zool. Bot Fenn. 1, 3: 37. 1921.

Zahlbruckner (1933) reported the present species from Taiwan, which is a typical Asian species characterized by conspicuous maculae, perforate apothecia, containing α-collatolic acid. The cited specimen (Taipei county: Tamsui, *U Faurie 318*) was not available for the present study.

EXCLUDED SPECIES

Parmotrema arisani (Zahlbr.) Wei, Enumeration of Lichens in China 164, 176. 1991.

Parmelia arisani Zahlbr., Repert. Spec. Nov. Regni Veg. 33: 57. 1933.

Zahlbruckner (1933) described *Parmelia (Amphigymnia) arisani* from Taiwan (Chiayi County: Nimandaira, Mt. Alisan, *Y. Asahina 85*). According to Hale (1965), it is a cetrarioid species necessitating further study. B. Hale & DePriest (1999) reduced *P. arisani* to a synonym of *Cetrelia collata.*

16. **PUNCTELIA** Krog

Nord. J. Bot. **2**: 290. 1982.

Punctelia is a cosmopolitan genus comprising 31 species, which shows a wide distribution in the temperate regions of the southern hemisphere, with some species extending their ranges to the northern hemisphere. It is characterized by grey sublinear lobes, punctiform pseudocyphellae, a nonpored epicortex and simple to furcate rhizines. Four species are known in Taiwan. Key references: Krog (1982); Krog & Swinscow (1977).

Key to the species

1. Thallus esorediate, with cylindrical to flattened isidia; medulla C+ red, lecanoric acid present .... *P. rudecta*
1. Thallus sorediate.
  2. Medulla C−, KC−, with caperatic acid .... *P. neutralis*
  2. Medulla C+ rose or red.
    3. Lower surface pale brown; medulla C+ red, lecanoric acid present .... *P. subrudecta*
    3. Lower surface black; medulla C+ rose, gyrophoric acid present . *P. borreri*

1. **Punctelia borreri** (Sm.) Krog, Nord. J. Bot. 2: 291. 1982.
Lichen borreri Sm., Engl. Bot. 25: Tab. 1780. 1807.
Parmelia pseudoborreri Asahina, J. Jpn. Bot. 26: 259. 1951.

Thallus corticolous or saxicolous, 6-8 cm in diameter; lobes rounded or irregularly incised, 5-8 mm wide; upper surface mineral grey to greenish grey; soralia mainly laminal, orbicular; pseudocyphellae small, punctiform; medulla white; lower surface black, rhizines simple, pale brown. Apothecia rare.

Chemistry: Cortex K+ yellow, medulla K−, C+ red, KC+ red, P−; atranorin and gyrophoric acid.

This species is widely distributed in temperate areas of the world. It is characterized by the irregular lobes with orbicular laminal soralia, black lower surface and the production of gyrophoric acid in the medulla.

Distribution: North America, South America, Australia, New Zealand, Europe, Africa, India, mainland China, Japan. New to Taiwan.

Specimens examined. Ilan Co.: Mt. Nanhutasan, *K. Yoshida 9875*, *9876*.

2. **Punctelia neutralis** (Hale) Krog, Nord. J. Bot. **2**: 291. 1982.
Parmelia neutralis Hale, Phytologia 22: 94. 1971.

Thallus adnate; lobes sublinear, 3-8 mm wide; upper surface pseudocyphellate, sorediate, soralia orbicular; lower surface pale brown, rhizines sparse.

Chemistry: Cortex K+ yellow, medulla K−, C−, KC−, P−; atranorin and caperatic acid.

The present species is characterized by the laminal orbicular soralia and the pale lower surface and the production of fatty acids related to caperatic acid (Hale 1971).

Distribution: South and East Africa (Krog & Swinscow 1977) and Taiwan (Kurokawa 1999a).

Specimen examined. Taichung Co.: Hoping, en route from Suyuan to Tochiatumsan, 2600 m alt., *H. Harada 9905-b*.

3. **Punctelia rudecta** (Ach.) Krog, Nord. J. Bot. **2**: 291. 1982.
Parmelia rudecta Ach., Syn. Meth. Lich. 197. 1814.
Parmelia ruderata Vain., Bot. Mag. Tokyo 35: 47. 1921.

Thallus saxicolous or corticolous, adnate, 6-8 cm in diameter; lobes 3-6 mm wide, subrotund, crenate or irregularly incised; upper surface mineral grey to greenish grey, centre of thallus rugose and ridged; isidia laminal, cylindrical, simple or coralloid, sometimes somewhat flattened; pseudocyphellae small, punctiform, or elongate, often developing into effigurate fissures; lower surface pale brown with long, slender, white or concolorous rhizines. Apothecia rare, with pseudocyphellate thalline exciple; spores subglobose or broadly ellipsoid, 8-10 × 10-16 μm.

Chemistry: Cortex K−, medulla K−, C+ red, KC+ red, P−; atranorin and lecanoric acid.

This species is distinguished from the other species of *Punctelia* by having isidia which often become lobulate, a pale lower surface and the production of lecanoric acid.

Distribution: Widely distributed in the temperate regions of the world. New to Taiwan.

Specimens examined. Taichung Co.: Lisan, *SK 876*. Ilan Co.: Mt. Nanhutasan, 2400-2600 m alt., *SK 1032*. Chiayi Co.: Susulu to Mt. Alisan, 2000-2200 m alt., *SK 622* (US).

4. **Punctelia subrudecta** (Nyl.) Krog, Nord. J. Bot. **2**: 291. 1982.
Parmelia subrudecta Nyl., Flora 69: 320. 1886.

Thallus loosely adnate; lobes ±rotund at apices, 6-8 mm wide; upper surface dull, pseudocyphellae laminal and marginal, soralia laminal and marginal; lower surface pale brown.

Chemistry: Cortex K+ yellow, medulla K−, C+ blood red, KC+ red, P−; atranorin, lecanoric acid and protolichesterinic acid (+or−).

The present species is characterized by farinose to granular soredia, pale brown lower surface, and lecanoric acid as a medullary product.

Distribution: Europe, Canary Island, New Zealand, India, North America and Taiwan (Kurokawa 1999a).

Specimen examined. Taichung Co.: Hoping, en route from Suyuan to Tochiatumsan. 2600 m alt., *H. Harada 9905-a*.

17. **RELICINA** (Hale & Kurok.) Hale
Phytologia **28**: 484. 1974.

Relicina is characterized by yellow green thallus lobes with bulbate cilia, a pored epicortex and a palisade-plectenchymatous upper cortex. It comprises 48 species and has a center of speciation in southeastern Asia and Australasia. Five species are know in Taiwan. Key references: Kurokawa (1965); Hale (1975b); Elix (1996).

Key to the species

1. Thallus isidiate or isidiate-lobulate.
  2. Isidia cylindrical.
    3. Lower surface pale brown .... *R. sydneyensis*
    3. Lower surface black .... *R. abstrusa*
  2. Isidia becoming lobulate .... *R. schizospatha*
1. Thallus lacking isidia.
  4. Medulla K+ red .... *R. subabstrusa*
  4. Medulla K− .... *R. malesiana*

1. **Relicina abstrusa** (Vain.) Hale, Phytologia **28**: 484. 1974.
Parmelia abstrusa Vain., Acta Soc. Faun. Fl. Fenn. 7: 64. 1890.

Thallus closely adnate; lobes sublinear, 1-2 mm wide; upper surface plane; isidia mostly simple to warty or clavate; cilia moderately inflated; lower surface black, rhizines simple, black. Apothecia coronate, retrorsely rhizinate.

Chemistry: Cortex K+ yellowish, medulla K+ yellow turning red, C−, KC −, P+ yellow turning orange; norstictic and usnic acids with or without connorstictic acid, and very rarely with diffractaic acid and a trace of barbatic acid.

This is a very common species distributed in both the New World and the Old World.

Distribution: Widely distributed in tropical and subtropical regions — North, South and Central America, southern Asia and Australia. Taiwan (Kurokawa 1965).

Specimens examined. Taipei Co.: Neihu, *Lai 6754* (Lai). Kaohsiung Co.: Shunsan, Mt. Nanfong, 1200 m alt., *SK 2931*. Pingtung Co.: Kural, 250 m alt., *SK 1480* (dupl. in US); Mt. Nanjensan, Hengchun, elevation about 350 m, *K. Yoshida 7090*.

2. **Relicina malesiana** (Hale) Hale, Phytologia **28**: 484. 1974.
Parmelia malesiana Hale, J. Jpn. Bot. 40: 203. 1965.

Thallus adnate; lobes 1.5-2.5 mm wide, soredia and isidia absent, cilia gradually inflated, lower surface dark brown or blackening, rhizines simple or squarrose. Apothecia ecoronate.

Chemistry: Cortex K−, medulla K−, C−, KC−, P+ red; atranorin (± trace), fumarprotocetraric acid and if pigmented an unidentified K+ purple anthraquinone.

The present species is characterized by the black lower surface which may be in part dark brown; rhizines when branched appear to be squarrose. Zahlbruckner (1933) reported *Parmelia limbata* Laur. (= *Relicina limbata* (Laur.) Hale) from Taiwan based on a specimen collected at Lienhwachih, Nantou County by Y. Asahina (*F-52*). This specimen contains fumarprotocetraric acid rather than stictic acid, and should be redetermined as *R. malesiana* (Kurukawa 1965).

Distribution: The Philippines, Sabah, Papua New Guinea and Taiwan (Kurokawa 1965).

Specimen examined. Nantou Co.: Lienhuachi, *YA F-52*.

3. **Relicina schizospatha** (Kurok.) Hale, Phytologia **28**: 485. 1974.
Parmelia schizospatha Kurok. in Hale and Kurokawa, Contr. U. S. Nat. Herb. 36: 146. 1964.

Thallus adnate; lobes sublinear, 1-2 mm wide, rather fragile, ciliate, cilia inconspicuous, bulbate, less than 0.4 mm; upper surface faintly maculate, densely lobulate along the margins, lobules procumbent; lower surface black, rhizines black, simple.

Chemistry: Cortex K+ pale yellow, medulla K+ yellow, C− or C+ yellow, KC−, P+ deep orange; usnic acid, atranorin (+or−), echinocarpic acid, and gyrophoric acid (±trace).

Relicina schizospatha seems to be a S. Asian species with range extension to Australia (Queensland) and Papua New Guinea.

Distribution: Malaysia, the Philippines, Sabah, Indonesia, Australia, Papua New Guinea and Taiwan (Kurokawa 1965).

Specimen examined. Pingtung Co.: Chinsueiin Pass, 400-1200 m alt., *SK 2990*.

4. **Relicina subabstrusa** (Gyeln.) Hale, Phytologia **28**: 485. 1974.
Parmelia subabstrusa Gyeln., Repert. Sp. Nov. Reg. Veg. 29: 288. 1931.

Thallus adnate, lobes sublinear, 0.5-2.0 mm wide, isidia and soredia absent, cilia strongly inflated, dense, ca. 1 mm long; lower surface black, rhizines long, simple, black. Apothecia coronate.

Chemistry: Cortex K+ pale yellow, medulla K+ yellow turning red, C−, KC−, P+ orange; usnic acid, norstictic acid, hyposalazinic acid (+or−) and diffractaic acid (±trace).

Relicina subabstrusa seems to be the primary morph of *R. abstrusa*, a widespread isidiate species.

Distribution: The Philippines, Sarawak, Indonesia, Australia, Comoro Islands, Brazil, Guyana, Paraguay and Taiwan (Kurokawa 1965).

Specimens examined. Taitung Co.: Antung Pass, 400-995 m alt., *SK 2665*. Kaohsiung Co.: Sanping, about 750 m alt., *SK 2732*. Pintung Co.: Chinsueiin Pass, 400-1200 m alt., *SK 2991*; Mt. Hiilan, 320 m alt., *SK 1541* (dupl. in US); Kusukusu, SK *1589*; Kural, 250 m alt., *SK 1478*, *1479*.

5. **Relicina sydneyensis** (Gyeln.) Hale, Phytologia **28**: 485. 1974.
Parmelia sydneyensis Gyeln., Ann. Mycol. 36: 292. 1938.
Parmelia subturgida Kurok., J. Jpn. Bot. 40: 268. 1965.

Thallus adnate; lobes 0.8-1.5 mm wide; upper surface faintly maculate, isidiate, isidia elongate-cylindrical, coralloid, cilia moderately inflated; lower surface dark brown, rhizines simple. Apothecia ecoronate, retrorsely rhizinate.

Chemistry: Cortex K+ yellowish, medulla K+ yellow turning red, C−, KC−, P+ orange; norstictic acid, usnic acid, stictic acid, with or without atranorin.

Relicina sydneyensis belongs to the *R. limbata* complex, which has a distribution center in Australasia, as Elix (1991) mentioned. While *R. limbata*, the primary species, is restricted to Australia, the present species, a secondary isidiate species, is more widely distributed also in Papua New Guinea, India, Indonesia, Taiwan and Japan.

Distribution: Japan, Java, India, Australia, Papua New Guinea and Taiwan (Kurokawa 1965 as *Parmelia subturgida*).

Specimen examined. Kaohsiung Co.: Mt. Nanfong, 800-1300 m alt., *SK 2833* (paratype of *Parmelia subturgida* Kurok.)

UNCERTAIN SPECIES

Relicina planiuscula (Kurok.) Hale, Phytologia **28**: 484. 1974.
Parmelia planiuscula Kurok. in Hale & Kurokawa, Contr. U. S. Nat. Herb. 36: 144. 1964.

Hale (1975b) reported this distinctly isidiate species from Taiwan but he did not cite any specimen collected in Taiwan. This record may be erroneous.

18. **RIMELIA** Hale & Fletcher
Bryologist **93**: 23. 1990.

Rimelia is a cosmopolitan genus comprising 17 species. It is characterized by broad, grey lobes, a reticulately maculate upper surface, a pored epicortex, a palisade-plectenchymatous upper cortex, simple to squarrosely branched rhizines and perforate apothecia. It has a center of speciation in South America. Three species are known in Taiwan. Key reference: Hale & Fletcher (1990).

Key to the species

1. Thallus sorediate 2
  2. Bare marginal zone of the lower surface brown .... *R. reticulata*
  2. Bare marginal zone of the lower surface forming a white rim .... *R. clavulifera*
1. Thallus lacking soredia .... *R. cetrata*

1. **Rimelia cetrata** (Ach.) Hale & A. Fletcher, Bryologist **93**: 26. 1990.
Parmelia cetrata Ach., Syn. Meth. Lich. 198. 1814.
Parmeotrema cetratum (Ach.) Hale, Phytologia 28: 335. 1974.

Thallus corticolous, loosely adnate, 15-20 cm in diameter, mineral grey to pale grey, laciniate-lobate; lobes rotund, up to 15 mm broad, crenate or deeply incised, laciniae well developed, 1-3 mm broad, with truncate apices; margin distinctly ciliate, cilia 0.5-2 mm long; upper surface dull, smooth, densely reticulately maculate and cracked, isidia and soredia absent; medulla white; lower surface black, densely rhizinate up to the margin, with a dark brown marginal zone, papillate, rhizines simple to frequently squarrosely branched. Apothecia stipitate, up to 10 mm in diameter, perforate; spores simple, 11-13 × 8-10 µm.

Chemistry: Cortex K+ yellow, medulla K+ red to red brown, C−, P+ orange red; atranorin, salazinic acid and consalazinic acid.

Rimelia cetrata may be the parent morph of *R. reticulata*, with well developed laciniae and being rhizinate to the margin on the lower surface.

Distribution: Widely distributed in pantemperate and pansubtropical regions. Taiwan (Zahlbruckner 1933 as *P. cetrata* f. *ciliosa*).

Specimens examined. Taipei Co.: En route from Keelung to Tamsui, *SK 1282*; Tyokutan, *T. Suzuki 11068*. Chiayi Co.: Tsutsonsan, Mt. Alisan, 2300-2900 m alt., *SK 139*.

2. **Rimelia clavulifera** (Räsänen) Kurok., J. Jpn. Bot. **66**: 158. 1991.
Parmelia clavulifera Räsänen, Ann. Bot. Soc. Zool.-Bot. Fenn. Vanamo 20 (3): 4. 1944.

Thallus loosely adnate; lobes 5-15 mm wide, ciliate, cilia 0.2-2 mm long; upper surface reticulately maculate, sorediate on the short laciniae, soralia capitate or spherical; lower surface black, with white mottled zone near the margins, rhizines more or less dense, simple or squarrosely branched.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning deep red, C−, P + orange yellow; atranorin, salazinic acid and fatty acids (+or−).

The present species is distinguished from *R. reticulata* by the presence of a white mottled zone near the margins on the lower surface of the lobes, especially when soralia are formed on the upper surface. It is noteworthy that fatty acids are sometimes demonstrated in the present species (Kurokawa 1979).

Distribution: Widely distributed in subtropical and temperate regions. New to Taiwan.

Specimens examined. Taipei Co.: Mt. Tatunsan, about 600 m alt., *H. Shibuichi 8195*. Ilan Co.: Piyanan, 1100-1300 m alt., *SK 750*; between Tulisan and Hoping, Taipingsan, about 2100 m alt., *H. Inoue 31*. Nantou Co.: Sun Moon Lake, *SK 1306-a, 1313*; Mt. Nanhutasan, 2400-2600 m alt., *SK 1035*; Mt. Suishetasan, vicinity of Sun Moon Lake, about 1000 m alt., *H. Shibuichi 7825*; Chitou, *YA s. n.* in 1933, *SK 1352*, *1353*, *1358;* the same locality, *Lai 1500*, *10501* (Lai). Chiayi Co.: Mt. Alisan, about 2200 m alt., *Jen-Rong Wang Yang 641* (Lai, TNS), *SK 33*. Kaohsiung Co: Sanping, about 750 m alt., *SK 2726*, *2727*; Mt. Nanfong, 800-1300 m alt., *SK 2801*, *2803*. Taitung Co: Antung Paso, 400-995 m alt., *SK 2662*; Mt. Lachialachiaerh, about 1800 m alt., *SK 2485*; Bayu Lake, about 2200 m alt., *SK 2388*, *2391*, *2389*, *2390*, *2392*.

3. **Rimelia reticulata** (Taylor) Hale & A. Fletcher, Bryologist **93**: 28. 1990.
Parmelia reticulata Taylor in Mackay, Fl. Hibern. 2: 148. 1836.
Parmotrema reticulatum (Taylor) M. Choisy, Bull. Mens. Soc. Linn. Lyon 21: 175. 1952.

Thallus corticolous, saxicolous, or terricolous, loosely attached, 6-20 cm in diameter, pale grey, ashy grey or mineral grey; lobes 0.5-1.5 cm wide, in part rounded and deeply crenate, in part irregularly incised and laciniate, sparingly to moderately ciliate, cilia 1-2 mm long; upper surface reticulately maculate and cracked, soralia marginal, subcapitate to linear; medulla white; lower surface black, rhizines mostly simple, occasionally squarrose; Apothecia submarginal to laminal, substipitate, thalline exciple sorediate, disc imperforate or narrowly perforate, spores ovoid, 6-10 × 13-18 ㎛.

Chemistry: Cortex K+ yellow, medulla K+ yellow turning deep red, C−, P+ orange red; atranorin and salazinic acid.

Rimelia reticulata has very variable soredia that form subcapitate to linear soralia along the lobe margins.

Distribution: Widely distributed in pantemperate and pantropical zones, Taiwan (Asahina 1951d).

Specimens examined. Taipei Co.: Mt. Tatunsan, Taipei. about 600 m alt., *H. Shibuichi 8195*. Miaoli Co.: Mt. Dapachiensan, *Lai 7783* (Lai). Ilan Co.: Piyanan, 1100-1300 m alt., *SK 748*, *749*; Mt. Nanhutasan, 2400-2600 m alt., *SK 1036*, *1038*; the same locality, 2600-3000 m alt., *SK 1194*, *1195*, *1196*, *1206*; between Tulisan and Hoping, Taipinsan, about 2100 m alt., *H. Inoue 37*; between Hiraiwa and Piyanan Pass, about 1800-2200 m alt., *H. Koizumi s. n.* in 1936. Taichung Co.: Anmasan, *Lai 6876* (Lai). Nantou Co.: Sun Moon Lake, *SK 1310*; the same locality, *YA s. n.* in 1933; Chitou, *YA s. n.* in 1933 (three specimens), *SK 1354*, *1356*, *1357*, *1381*. Chiayi Co.: Mt. Alisan, *YA F-65a*; Mt. Alisan 2200 m alt., *SK 34*, *35*; Tsutsonsan, Mt. Alisan, 2300-2900 m alt., *SK 141*, *142*, *143*, *144*, *145*; Tsutsonsan, Mt. Alisan, 2200-2600 m alt., *SK 480*, *481*, *483*; en route from Funchifu to Chalapin, 1300-1600 m alt., *SK 525*; en route from Susulu to Mt. Alisan, 2000-2200 m alt., *SK 616*, *617*, *618*, *619*; Kuwarus, *E. Ochiai* (Herb. Asahina no. *F-65*); Mt. Morrison, *Lai 10354* (Lai). Kaohsiung Co.: Mt. Nanfong, 800-1300 m alt., *SK 2800*, *2802*; Mt. Nanfong, 1300-1500 m alt., *SK 2904*; Shunsan, Mt. Nanfong, about 1200 m alt., *SK 2924*. Taitung Co.: Mt. Lachialachiaerh, about 1800 m alt., *SK 2486*; Mt. Lachialachiaerh, about 1900 m alt., *SK 2568*, *2569*; Bayu Lake, about 2200 m alt., *SK 2385*, *2393*; Chokakurai, *H. Masuda s. n.* in 1936.

19. **XANTHOPARMELIA** (Vain.) Hale
Phytologia **28**: 485. 1974.

Xanthoparmelia is the largest genus in the Parmeliaceae, with nearly 500 species and shows a cosmopolitan distribution. It has centers of speciation in Australia and South Africa. It is characterized by a saxicolous or terricolous habitat, narrow lobes without cilia, a pored epicortex and simple to furcate rhizines. Three species are known in Taiwan. Key references: Elix *et al.* (1986); Hale (1990); Kurokawa (1989a, 1989b, 1989c).

Key to the species

1. Lower surface brown to dark brown; isidia subglobose or subclavate and often subcoralloid-branched, branchlets constricted at base; medulla P−, containing norlobaridone.. *X. claviculata*

1. Lower surface blackish brown to black; isidia subglobose or cylindrical becoming coralloid-branched at maturity; medulla P+ orange yellow, containing salazinic acid.

2. Isidia 0.1-0.2 mm wide, when branched 0.15-0.3 mm wide ...... *X. orientalis*

2. Isidia more slender, 0.05-0.1 mm wide........................ *X. formosana*

1. **Xanthoparmelia claviculata** Kurok., J. Jpn. Bot. **64**: 296. 1989.

Thallus adnate to moderately adnate, yellow-green, saxicolous; lobes sublinear-elongate, 0.8-2.0 cm wide; upper surface emaculate, often black margined near lobe apices; simple isidia subglobose to subclavate up to 0.25 mm in height and 0.07-0.15 mm in diameter, branched isidia subcoralloid, often more than 0.4 mm in height and 0.12-0.15 mm in diameter, branchlets constricted near the base; medulla white; lower surface brown to dark brown; rhizines simple.

Chemistry: Cortex K−, medulla K−, C−, KC+ rose, P−; usnic acid, norlobaridone (major), loxodin (±trace) and two unknown substances (trace).

The present species resembles *X. scabrosa* (Taylor) Hale, from which it is distinguished by subglobose or subclavate isidia never opened at the apices.

Distribution: Taiwan and Japan.

Specimen examined. Taipei Co.: En route from Keelung to Tamsui, *SK 1279-b*.

2. **Xanthoparmelia formosana** Kurok., *sp. nov.*

Xanthoparmelia formosana Kurok., Ann. Tsukuba Bot. Gard. 8: 22 1989. (*nom. inval.*)

Thallus adnate on rocks, pale yellow-green; lobes subirregular, more or less imbricate, 0.8-2.0 cm wide; upper surface dull, emaculate, densely isidiate, isidia simple or coralloid-branched, 0.05-0.1 mm in diameter, often more than 0.5 mm in height; medulla white; lower surface black, moderately rhizinate, rhizines not coarse. Apothecia not seen.

Chemistry: Cortex K−, medulla K+ yellow turning red, C−, KC− P+ intense yellow; usnic acid, salazinic acid and consalazinic acid (minor).

When the present species was described, Kurokawa (1989c) did not designate the holotype and so the name was invalid though the Latin diagnosis was given. It is now validated by the designation of the type as follows. Type collection: Chiayi Co.: Shisan, Mt. Morrison, 3300-3600 m, *S. Kurokawa 261* (holotype in TNS).

Distribution: Endemic to Taiwan.

3. **Xanthoparmelia orientalis** Kurok., J. Jpn. Bot. **64**: 169. 1989.

Thallus adnate to loosely adnate, yellow-green, saxicolous; lobes subirregular to sublinear, 1.0-2.5 cm wide; upper surface dull, sometimes faintly white-maculate, isidiate, isidia subglobose to cylindrical and later often coralloid-branched; medulla white; lower surface brown or blackish brown in rather broad zone near lobe apices and black in the center; rhizines sparse, simple, coarse, 0.1-0.7 mm long. Apothecia rare, adnate, 2-7 mm in diameter, disc chestnut-brown, more or less concave, margin crenate, amphithecium isidiate; spores colorless, simple, 5 × 10-11 μm. Pycnidia not seen.

Chemistry: Cortex K−, medulla K+ yellow turning red, C−, KC− P+ intense yellow; usnic acid, salazinic acid (major), norstictic acid (minor or trace) and consalazinic acid (minor).

This species is characterized by subglobose to cylindrical isidia, a blackish brown to black lower surface with a rather broad brown zone towards the apices and salazinic acid.

Distribution: Taiwan and Japan.

Specimens examined. Taipei Co.: En route from Keelung to Tamsui, *SK 1279-a*; Sanchih, *Lai s. n.* in 1998 (Lai).

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MYXOMYCETES FROM DIFFERENT FOREST TYPES IN PUERTO RICO

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Abstract: Forty-four species of myxomycetes, collected during a four-week survey in 1998, are reported from Puerto Rico. Two species are recorded as new for the Caribbean Region, and eight species are new records for Puerto Rico. Information about the distribution within the Caribbean Region is provided for each of the species collected. Among different forest types occurring along an elevation gradient that extends from sea level to 1000 m, remarkable differences in myxomycete distribution were observed, with a clear pattern of decreasing myxomycete diversity with increasing elevation.

Key words: biodiversity, myxomycetes, Puerto Rico, Neotropics, taxonomy

INTRODUCTION

The myxomycetes (plasmodial slime moulds) of most areas of the Neotropics are still rather poorly known. This is certainly the case for Puerto Rico, although a number of published reports (Klotzsch 1852; Stevens 1917; Seaver & Chardon 1926; Toro 1926; Hagelstein 1927, 1932; Farr 1969; Alexopoulos 1970; Stevenson 1975; Farr 1976; Lodge 1996; Nieves-Rivera & Santos-Flores 1998; Stephenson et al. 1999) do exist. However, many species are known from only a few localities, and information about their distribution in Puerto Rico is rather fragmentary. This paper reports the results of a systematic field survey carried out primarily along an elevational gradient in the Luquillo Mountains in north-eastern Puerto Rico. Field work was conducted during a four-week period (June 24 to July 19) in early summer of 1998.

The primary objective of the survey was to investigate distributional relationships of myxomycetes in the different forest types of Puerto Rico. A second goal was to obtain baseline data on the species of myxomycetes associated with forest floor litter and decaying wood. As such, our survey supplements the data reported by Stephenson et al. (1999) for litter-inhabiting myxomycetes recorded from moist chambers with additional data on wood- and litter-inhabiting species obtained as field collections.

MATERIALS AND METHODS

Study sites were chosen to encompass a major part of the diversity represented by the forest types found in Puerto Rico. These included coastal forests as well as four inland forest types roughly stratified by elevation (Brown et al. 1983; Stephenson et al. 1999). For each forest type, one to several collecting sites were examined, and a transect 200–500 m long and 6 m wide was established and searched thoroughly for all visible myxomycete fructifications. An effort was made to examine all types of microhabitats suitable for myxomycetes. These included the bark surface of living trees, coarse woody debris (logs), palm leaf debris, leaf litter and decaying tree fruits on the forest floor, and aerial litter. Dung of herbivorous animals, which represents a potential microhabitat for myxomycetes in temperate forests (Eliasson & Keller 1999) but is almost totally absent in tropical forests, was never encountered in the present study.

Fruitings of common and easily recognizable species of myxomycetes were only occasionally collected but always recorded. Rare species and those not easily identified in the field were always collected. For the purposes of this study, all sporocarps that could have arisen from a single plasmodium were defined as one specimen. In practice, we assumed that sporocarps that share the same substrate and are separated by a distance that could be overcome by a migrating plasmodium belonged to the same plasmodium. For determination, sporocarps were mostly preserved as permanent slides in polyvinyl lactophenol and/or glycerol gelatin, to distinguish between limeless and lime-containing structures. In several cases, specimens also were studied with a JEOL 35c scanning electron microscope in the laboratory of the first author. All collections reported herein were deposited in the herbarium of the Komarov Botanical Institute, St. Petersburg (LE). In addition, duplicates of most specimens were placed in the herbarium of Fairmont State College (FWVA).

STUDY SITES

Most of the field collections considered in this paper were obtained from the Luquillo Experimental Forest (LEF), located in the Luquillo Mountains in northeastern Puerto Rico (18°20′ N, 65°49′ W). In addition, some collecting was carried out in coastal forests located along the northern and southern coasts of the island. In the list that follows, all collection sites are assigned to one of seven forest types (numbers according to Fig. 1).

Coastal forests. – Mangrove forests (abbreviation *MF*) are restricted to protected shores of bays, lagoons and river estuaries. These forests tend to be characterized by almost pure stands of mangroves at the waterline. Mainly investigated in the present study were stands of white and black mangrove, named after their dominant tree species, *Laguncularia racemosa* (L.) Gaertn. fil. and *Avicenna germinans* (L.) L., respectively. Mangrove forests are subject to tidal flooding, at least at high tide. Because if this, larger logs as well as leafy litter rarely accumulate. Two sites were investigated:

1. Playa San Agustin, 11 km NW of Luquillo (18°24′00′′ N, 65°49′00′′ W), ca. 1–2 m above sea level; and
2. Loiza, National Forest "De Pinones", on road 187, 3.2 km NW of Loiza (18°27′00′′ N, 65°53′00′′ W), ca. 1–2 m above sea level.

Moist coastal forests (*MCF*) support on protected sites numerous larger, evergreen trees which often possess very hard, leathery leaves. *Coccoloba uvivera* (L.) L. is a common and often abundant tree in these forests. A considerable amount of leafy litter tends to accumulate on sheltered sites, especially those located above the influence of normal tides. One locality was studied:

3. Sea shore ca. 5 km E of Luquillo (18°22′00′′ N, 65°39′00′′ W), 3–10 m above sea level.

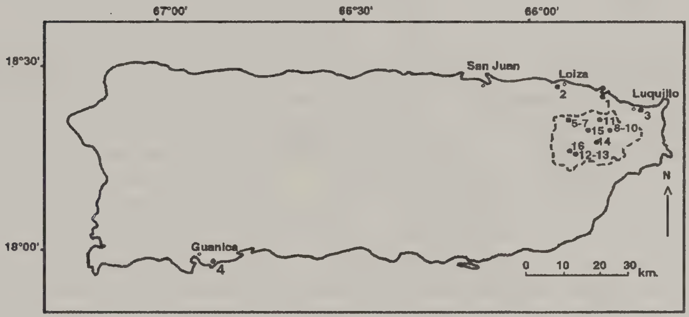


Fig. 1 Map of Puerto Rico showing the locations of the 16 sampling sites and the boundaries of the Luquillo Experimental Forest (dashed line); modified from Brown et al. (1983).

With an annual rainfall as low as 750 mm, the dry coastal forests (*DCF*) along the southern coast represent the most xeric vegetation type found in Puerto Rico. Over limestone the forest is semideciduous and shrubby in habit. Abundant leafy litter is usually present, but this dries out completely during a few sunny days. One dry limestone forest was studied:

4. National Forest "De Guanica", ca. 5 km SW of Guanica (17°58′00′′ N, 66°52′00′′ W), 150–250 m elevation.

In the understory of this forest, cacti were frequently observed. Decaying plants establish a special microhabitat for myxomycetes (Lado et al. 1999). Although cactus debris was always checked, no myxomycete fructifications were found. However, moist chamber cultures of this substrate were positive for myxomycetes (yielding *Badhamia gracilis* (T. Macbr.) T. Macbr. and *Cribraria confusa* Nann.-Bremek. & Y. Yamam., unpubl. results).

Inland forests. – All investigated inland study sites are located within the four main forest types described in detail by Stephenson et al. (1999). All (tabonuco, palo colorado, palm, and elfin forest) are situated along an elevational gradient in the Luquillo Experimental Forest.

Tabonuco forest (***TF***, including both secondary as well as relatively undisturbed woodlands) occurs below 600 m elevation. Tall, evergreen canopy-forming trees, with *Dacryodes excelsa* Vahl (tabonuco) as the primary dominant, supply coarse woody debris of various sizes, including large logs up to 1 m in diameter. The litter layer can dry out at the surface but remains permanently moist at least at the soil-litter interface. Seven sites were investigated:

5. El Verde Research Area near the Field Station, point K 19.5 (18°19′24′′ N, 65°49′30′′ W);

6. El Verde Research Area, along the Odum trail (coordinates approximately the same as locality 5);

7. El Verde Research Area, La Prieta trail near the bridge over Sanadora Creek, about 400 m elevation (coordinates approximately the same as locality 5);

8. Angelita Road (18°19′25′′ N, 65°45′00′′ W), 100 m elevation;

9. Secondary tabonuco forest near the Mycology Laboratory at the Sabana Work Center (18°19′50′′ N, 65°43′50′′ W), 100 m elevation;

10. La Cocca Trail (exit trail), point K 8.6 (18°18′15′′ N, 65°46′10′′ W), 350 m elevation; and 11. El Toro Mountain, point K 10.8, Rio Jimenez, on road 966 (18°20′00′′ N, 65°47′30′′ W), 400 m elevation.

Palo colorado forests (***CF***), usually found between 600 and 750 m elevation, derive their name from the dominant tree species (*Cyrilla racemiflora* L.). This forest type is characterized by a higher annual precipitation than tabonuco forest, which keeps the litter layer at least somewhat moist the year around. Large and well-decayed logs are often present. The two investigated sites were:

12. El Toro Mountain, point K 10.8, El Toro National Recreation Trail, 1 km from the entry point (18°16′00′′ N, 65°50′00′′ W), 950 m elevation; and

13. El Toro Mountain, point K 10.8, middle portion of the El Toro National Recreation Trail (18°16′00′′ N, 65°50′30′′ W), 750 m elevation.

Palm forests (***PF***) occur on steeper slopes with poor drainage within the same elevation range as palo colorado forests. *Prestoea montana* (R. Grah.) Nicols. (sierra palm) is the dominant tree species. One site was investigated:

14. Below Mt. Britton Tower, point K 13.41, near the exit of the access road (18°17′30′′ N, 65°47′45′′ W), 750 m elevation.

Elfin forests (***EF***) occur above 750 m on soils that are highly leached as a result of rainfall amounts in excess of 4000 mm per year. The lower temperatures and higher wind exposure characteristic of such sites produce a dwarf forest, with tree trunks twisted and branching close to the ground. Lush epiphyte covers of mosses and liverworts on the trunks and branches of the trees support various hymenophyllaceous ferns and bromeliads. The litter layer is always moist and leafy litter is usually covered by a water film. Two sites were studied:

15. Mt. Pico El Yunque, near Los Picachos Tower (18°19′40′′ N, 65°47′30′′ W), 1000 m elevation; and

16. El Toro Mountain, El Toro National Recreation Trail (18°16′00′′ N, 65°50′00′′ W), 950 m elevation.

ANNOTATED SPECIES LIST

The following annotated list includes all species of myxomycetes recorded in the present study. Species are listed in alphabetical order; nomenclature follows Martin & Alexopoulos (1969). After each species name, a letter in brackets refers to an abundance estimation as described by Stephenson et al. (1993). It is based on the proportion of a species to the total number of records (221): R – rare (<0.5 %): recorded once, O – occasional (0.5–1.5 %): (2–3 records in this study), C – common (>1.5–3 %): (4–7 records), A – abundant (>3 %): more than 7 records. It should be noted that these abundance estimations characterize only the investigated June-July aspect, not the occurrence of a particular species over the entire year.

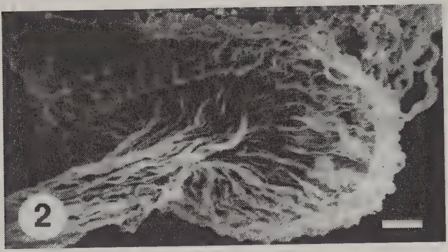
For each myxomycete species, the number of records on each type of substrate is given for each forest type. Abbreviations of forest types (written in bold italics) are as explained above. The number of records is followed by a dash and the respective substrate type, classified as wood (mostly decorticated, large logs with strongly decayed, soft wood); bark (bark of living trees, including the outer covering on the lower trunks of palms); leafy litter (decaying leaves on the forest floor); palm litter (coarse non-rachis portions of palm leaves); and aerial litter (dead but still attached parts of palms, tree ferns and bromelids).

In addition, the hitherto known distribution in the Caribbean Region is given for each species, using the abbreviations given below for the countries involved (with literature sources in parentheses): AG – Antigua (Lister 1898b); BB – Barbados (Farr 1976); CU – Cuba (Berkeley 1869, Vilaró 1991, 1998a, b); DM – Dominica (Lister 1898a, b, Farr 1969); DO – Dominican Republic (Ciferri 1961); GR– Grenada (Farr 1976); HT – Haiti (Benjamin 1969); JM – Jamaica (Alexopoulos & Beneke 1954a, b, Farr 1957); PR – Puerto Rico (literature as given in the introduction); TT – Trinidad and Tobago (Baker & Dale 1951, Barnes 1963); VC – St. Vincent (Farr 1976); VI – Virgin Islands (Seaver & Chardon 1926, Stevenson 1975). Moreover, literature sources reporting the particular species for Puerto Rico as well as major herbaria housing specimens from the island are given.

Arcyria cinerea (Bull.) Pers. [A] (***MF***: 1 – wood; ***MCF***: 2 – wood; ***TF***: 1– bark, 5 – wood, 3 – leaf litter; ***CF***: 6 – wood; ***PF***: 2 – wood; ***EF***: 1 – leaf litter), Figs. 2–3. – AG, CU, DM, DO, HT, JM, PR, TT, VI.

Lit.: Seaver & Chardon 1926; Toro 1926; Hagelstein 1927, 1932; Farr 1969; Alexopoulos 1970; Farr 1976; Stevenson 1975; Lodge 1996; Stephenson et al. 1999; BPI, FN, NY.

This very variable species is one of the most common myxomycetes in Puerto Rico as well as throughout the Neotropics. Shape, size and color of the sporocarps vary considerably among collections (Farr 1976). Three collections (LE 204883, 204915, 204916), found on leafy litter in association with *Comatricha lurida* Lister, have several features deviating from collections of *A. cinerea* made from wood. Sporocarps are cream to very light grey, globose and very small (0.1–0.3 mm in diameter), with comparatively long stalks. The calyculus is a very shallow disk (Fig. 2) marked with warts partially forming a reticulum. However, the capillitium is typically dimorphic, as described for *A. cinerea* by Härkönen (1977), ornamented with cogs in the upper portion (Fig. 3) but almost smooth near the calyculus.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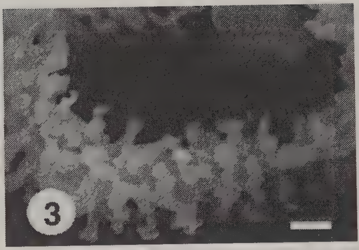
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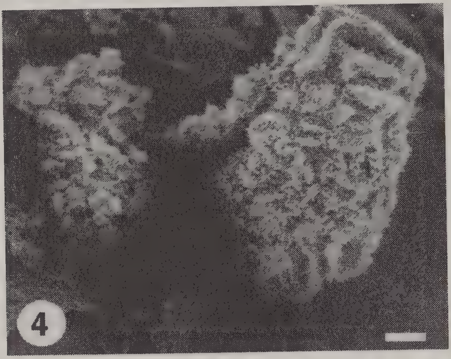
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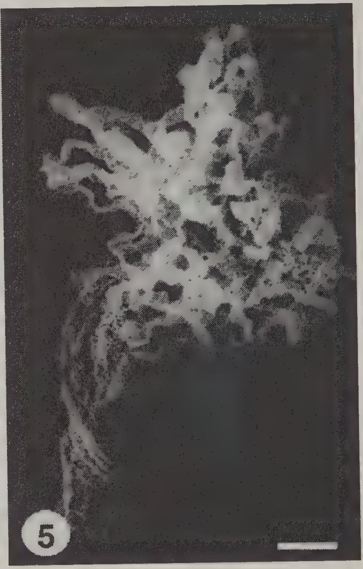
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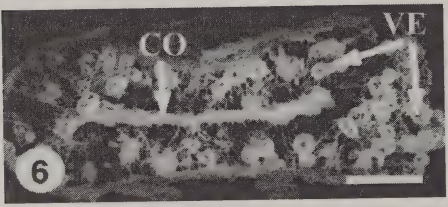
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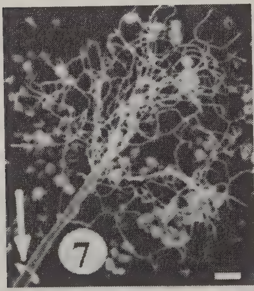
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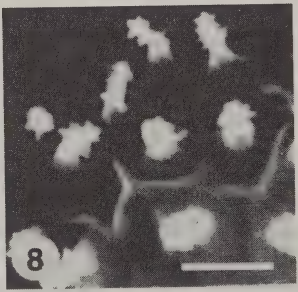
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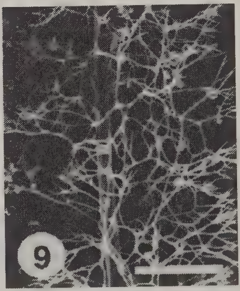
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Arcyria denudata (L.) Wettst. [C] (***TF***: 2 – wood; ***CF***: 2 – wood). – AG, CU, DM, DO, HT, JM, PR, TT, VI.
Lit.: Klotzsch 1852; Seaver & Chardon 1926; Hagelstein 1927; Farr 1969; Stevenson 1975; Farr 1976; Lodge 1996; BPI, FH, NY.

Arcyria incarnata (Pers.) Pers. [O] (***MF***: 1 – wood; ***MCF***: 1 – wood). – AG, CU, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976.

Ceratiomyxa fruticulosa (O.F. Müll.) T. Macbr. [A] (***TF***: 1 – palm litter, 4 – wood; ***CF***: 7 – palm litter, 2 – wood; ***PF***: 1 – bark; ***EF***: 1 – wood). – AG, CU, DM, HT, JM, PR, TT, VI.
Lit: Seaver & Chardon 1926; Hagelstein 1932; Alexopoulos 1970; Stevenson 1975; Lodge 1996; Nieves-Rivera & Santos-Flores 1998; BPI.

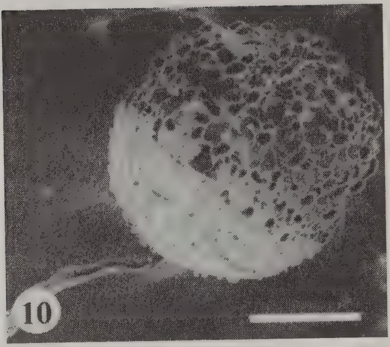
Ceratiomyxa morchella A.L. Welden [O] (***PF***: 1 – wood; ***EF***: 1 – wood), Fig. 4. – PR.
Lit.: Alexopoulos 1970; Stevenson 1975; Lodge 1996.

Ceratiomyxa sphaerosperma Boedijn [A] (***TF***: 9 – dead tree fruits, 1 – leaf litter), Fig. 5. – JM.
Recorded as new for Puerto Rico, this species was found repeatedly on fruits of *Andira inermis* (W. Wright) DC. decaying on the forest floor, with fructifications only occasionally occurring on adjacent leafy litter. Moist chamber cultures of these fruits (results not presented herein) produced a number of additional records.

Comatricha longa Peck [R] (***TF***: 1 – wood), Fig. 9. – AG, CU, DM, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1927; Farr 1969; Stevenson 1975; Farr 1976.

Comatricha lurida Lister [O] (***TF:*** 2 – leaf litter), Figs. 7–8. – PR.
Lit.: Stephenson et al. 1999.
Both specimens were found in association with small, globose sporocarps of *A. cinerea* (LE 204883, 204915, 204916). Examination of this rarely collected species under SEM revealed an unique spore ornamentation (Fig. 8) consisting of branched spines up to 0.8 µm tall, each bearing 5–7 perpendicular branches up to 0.3 µm long. Further investigations are necessary to verify that this is a diagnostic character for the species.

Figs. 2–9. Scanning electron micrographs (SEM) of *Arcyria cinerea* (2–3, LE 204915), *Ceratiomyxa morchella* (4, LE 204758), *Ceratiomyxa sphaerosperma* (5, LE 204171), *Didymium flexuosum* (6, LE 204867), *Comatricha lurida* (7–8, LE 204917), and *Comatricha longa* (9, LE 204792). 2 Calyculus of *A. cinerea*; bar = 10 µm. 3 Ornamentation of the capillitium; bar = 1 µm. 4 Sporocarps of *C. morchella*; bar = 100 µm. 5 Sporocarp of *C. sphaerosperma*; bar = 100 µm. 6 Opened sporocarp of *D. flexuosum* (an arrow CO points to the columella, arrows VE point to the vesicular bodies); bar = 100 µm. 7 Opened sporocarp of *C. lurida* (an arrow points to the peridial collar); bar = 10 µm. 8 Spore ornamentation; bar = 1 µm. 9 Capillitium of *C. longa*; bar = 100 µm.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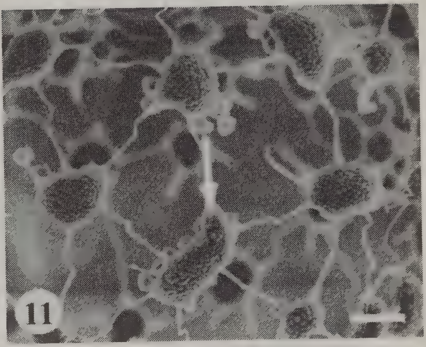
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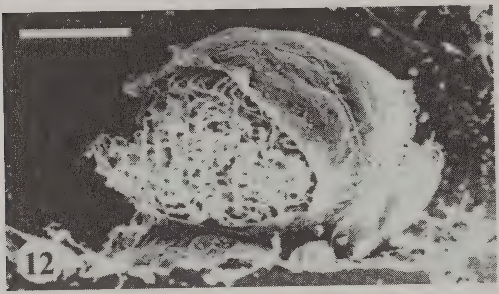
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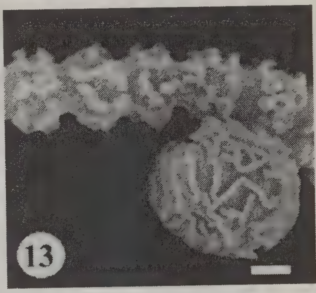
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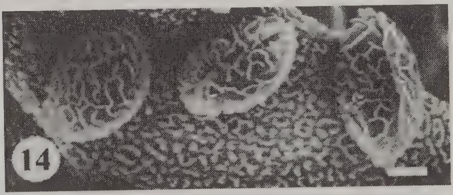
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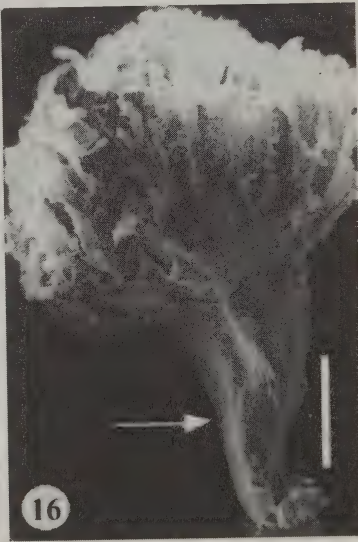
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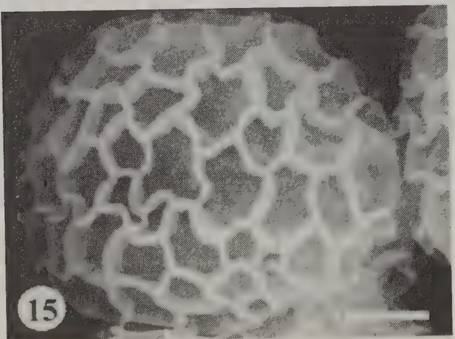
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Comatricha typhoides (Bull.) Rostaf. [R] (*MF*: 1 – on a dead leaf of *Agave* sp.) – AG, CU, DM, DO, HT, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Farr 1969; Stevenson 1975; Farr 1976.

Craterium aureum (Schum.) Rostaf. [R] (*TF*: 1 – leaf litter). – HT, JM, PR.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; BPI.

Craterium paraguayense (Speg.) G. Lister [C] (*TF*: 6 – leaf litter).
These records are new for Puerto Rico.

Clastoderma debaryanum A. Blytt [O] (*TF*: 2 – wood; *CF*: 1 – wood). – BB, JM, PR, TT.
Lit.: Stephenson et al. 1999.

Cribraria languescens Rex [C] (*TF*: 5 – wood), Figs. 10-11. – AG, DM, JM, PR, TT, VI.
Lit.: Farr 1969.

Cribraria microcarpa (Schrad.) Pers. [C] (*TF*: 2 – leaf litter, 1 – palm litter, 1 – wood; *CF*: 1– palm litter). – BB, DM, JM, PR, TT.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; Stephenson et al. 1999.

Cribraria tenella Schrad. [A] (*TF*: 7 – wood; *CF*: 3 – wood). – AG, DM, HT, JM.
A new record for Puerto Rico. This species seems to intergrade with the closely related *C. intricata*, recorded previously from Puerto Rico (e.g., Nieves-Rivera & Santos-Flores 1998). We consider the distinguishing characters of *C. tenella* to be the always present, shining calyculus, the more regular peridial net almost lacking free ends, the smaller size, and the slightly darker color.

Diachea leucopodia (Bull.) Rostaf. [R] (*MCF*: 1 – leaf litter). – AG, CU, DM, DO, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Farr 1969; Stevenson 1975; Farr 1976; BPI, FH.

Figs. 10–16. SEM micrographs of *Cribraria languescens* (10–11, LE 204764), *Perichaena microspora* (12–14, LE 204870), and *Tubifera microsperma* (15–16, LE 204791). 10 Sporotheca of *C. languescens*; bar = 100 µm. 11 Threads and nodes of the peridial net (an arrow points to a node); bar = 10 µm. 12 Opened sporocarp of *P. microspora*; bar = 100 µm. 13 Ornamentation of the capillitium and one spore; bar = 1 µm. 14 Ornamentation of the inner surface of the peridium and collapsed spores; bar = 1 µm. 15 Spore of *T. microsperma*; bar = 1 µm. 16 Pseudoaethalium of *T. microsperma* (an arrow points to the stalk-like hypothallus); bar = 1000 µm.

Diderma effusum (Schwein.) Morgan [C] (***TF***: 4 – leaf litter). – AG, DM, JM, PR, TT.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; Stephenson et al. 1999; BPI.

Didymium flexuosum Yamashiro [R] (***TF***: 1 – on leaf litter), Fig. 6.
Reported as new for the entire Neotropical Region. Vesicular bodies interspersed with the capillitium and a columella extending as a rim over the whole length of the plasmodiocarps are the distinguishing characters of this species, leaving room for confusion only with *D. serpula* Fr., which has smaller spores and lacks a columella.

Didymium iridis (Ditmar) Fr. [A] (***TF***: 21 – leaf litter). – AG, DM, DO, HT, JM, PR, TT.
Lit.: Alexopoulos 1970; Stevenson 1975; Farr, 1976; Lodge 1996; Stephenson et al. 1999; BPI, NY.

Didymium nigripes (Link) Fr. [O] (***TF***: 2 – leaf litter). – AG, DM, DO, HT, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Toro 1926; Hagelstein 1927, 1932; Farr 1969; Stevenson 1975; Farr 1976; Lodge 1996; BPI.

Hemitrichia calyculata (Speg.) M.L. Farr [A] (***MCF***: 1 – wood; ***TF***: 2 – leaf litter, 1 – palm litter, 2 – wood; ***CF***: 1 – palm litter; 8 – wood; ***PF***: 1 – wood; ***EF***: 1 – wood). – AG, CU, DM, DO, HT, JM, PR, TT, VI.
Lit.: Farr 1969; Alexopoulos 1970; Stevenson 1975; Farr 1976; Lodge 1996; BPI, FH.

Hemitrichia serpula (Scop.) Rostaf. [C] (***TF***: 2 – palm litter, 1 – leaf litter; ***CF***: 2 – palm litter, 1 – wood). – AG, CU, DM, DO, HT, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; BPI CUP, FH, NY.

Lamproderma arcyrionema Rostaf. [A] (***TF***: 2 – palm litter, 1 – leaf litter; 6 – wood; ***CF***: 2–palm litter, 1 – wood). – AG, CU, DM, DO, HT, JM, PR.
Lit.: Hagelstein 1927; Stevenson 1975; Farr 1976.

Lamproderma scintillans (Berk. & Broome) Morgan [R] (***TF***: 1 – wood). – AG, DM, HT, JM, PR.
Lit.: Stephenson et al. 1999.

Lycogala epidendrum (L.) Fr. [C] (***TF***: 2 – wood; ***PF***: 1 – wood; ***CF***: 1 – wood; ***EF***: 2 – wood). – AG, CU, DM, DO, HT, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1927, 1932; Farr 1969; Alexopoulos 1970; Stevenson 1975; Farr 1976; Lodge 1996; BPI.

Lycogala exiguum Morgan [R] (***TF***: 1 – wood). – DM, JM, PR.
Lit.: Farr 1976; NY.

Metatrichia vesparium (Batsch.) Nann.-Bremek. [R] (***TF***: 1 – wood). – AG, CU, DM, DO, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; BPI, FH.

Oligonema cf. *flavidum* (Peck) Peck [A] (***MCF***: 8 – leaf litter).
Reported as new for the entire Neotropical Region; found repeatedly in only one locality. For all collections, the microhabitat consisted of strongly decayed leaves in deeper layers of litter, often directly over wet sand, in places far enough from the seashore to be sheltered from regular tides but flooded during high tides.
Globose to cylindrical, sessile sporocarps, gregarious or scattered, bright yellow to ochraceous, rarely yellow-brown, 1–2 mm wide, sometimes coalescing to small form pseudoaethalia. Peridium persistent, membranous, thin, translucent in transmitted light, dehiscing irregularly from the apex. Hypothallus inconspicuous, scanty. Capillitial threads absent. Spores bright yellow in mass and also by transmitted light, ornamented with ridges up to 1.5 µm high that form a coarse network consisting of 2–4 meshes per spore diameter, the body of the spores 11–12.5 µm, with the ridges 14–15 µm in diameter. With its scanty hypothallus, bright yellow sporocarps and the prominently reticulate spore ornamentation, these specimens fit the concept of *Oligonema flavidum*. However, the latter species is described as possessing a capillitium.

Perichaena microspora Penz. & Lister [O] (***TF***: 2 – leaf litter), Figs. 12–14.
This rarely collected species is a new for the Caribbean Region, probably as a result of its very inconspicuous sporocarps.

Physarum bogoriense Racib. [R] (***TF***: 1 – leaf litter). – AG, DM, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932, 1944; Farr 1969; Stevenson 1975; Farr 1976; Stephenson et al. 1999.

Physarum cinereum (Batsch) Pers. [R] (***TF***: 1 – leaf litter). – AG, CU, DM, DO, HT, JM, PR, TT.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; BPI.

Physarum galbeum Wingate [C] (***TF***: 7 – leaf litter). – DM, JM.
A new record for Puerto Rico. Bright golden-yellow sporocarps similar in habit to *Craterium aureum* (Schum.) Rostaf. seem to be typical for this species. However, the small lime nodes and the almost smooth, pale violet brown spores leave no doubt about the placement of this taxon in *Physarum*.

Physarum melleum (Berk. & Broome) Massee [A] (***TF***: 1 – palm litter, 12 – leaf litter). – AG, DM, DO, HT, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1927, 1932; Farr 1969; Stevenson 1975; Stephenson et al. 1999; NY.

Physarum nutans Pers. [C] (***MF***: 1 – wood; ***TF***: 2 – bark; ***CF***:, 2– palm litter). – DM, DO, HT, JM, PR, TT.
Lit.: Hagelstein 1927, 1932; Farr 1969; Stevenson 1975; Farr 1976; Stephenson et al. 1999; NY.

Physarum polycephalum Schwein. [R] (***MF***: 1 – wood). – CU, DM, JM, PR, TT, VI.
Lit.: Hagelstein 1927, 1932; Farr 1969; Stevenson 1975; Farr 1976.

Physarum serpula Morgan [O] (***TF***: 2 – leaf litter; ***CF***: 1 – bark). – JM, TT.
A new record for Puerto Rico.

Physarum stellatum (Massee) G.W. Martin [A] (***TF***: 2 – palm litter; 1 – leaf litter, 2 – wood; ***CF***: 5 – wood; ***EF***: 1 – wood). – AG, DM, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; BPI, FH.

Physarum tenerum Rex [R] (***TF***: 1 – wood). – AG, DM, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; Lodge 1996; Stephenson et al. 1999.

Physarum viride (Bull.) Pers. [R] (***TF***: 1 – wood). – AG, BB, DM, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Hagelstein 1932; Farr 1969; Stevenson 1975; Farr 1976; BPI, FH, NY.

Stemonitis fusca Roth [O] (***MCF***: 1 – wood; ***TF***: 1 – wood; ***CF***: 1– wood). – AG, CU, DO, JM, PR, TT, VI.
Lit.: Seaver & Chardon 1926; Farr 1969; Stevenson 1975; Farr 1976.

Stemonitis smithii T. Macbr. [R] (***TF***: 1 – wood). – AG, DM, JM, PR, TT.
Lit.: Stevenson 1975; Farr 1976.

Stemonitis splendens Rostaf. [C] (***MCF***: 1 – wood; ***TF***: 3 – wood). – AG, CU, DM, JM, PR, TT.
Lit.: Seaver & Chardon 1926; Farr 1969; Stevenson 1975; Farr 1976.

Trichia favoginea (Batsch) Pers. [R] (***CF***: 1 – leaf litter). – CU, DM, DO, HT, JM, PR, TT, VI.
Lit.: Farr 1969; Stevenson 1975; Farr 1976; BPI, FH.
The very variable spore ornamentation is the reason to include *T. persimilis* Karst. and *T. affinis* de Bary in a broad species concept of *T. favoginea* (Farr 1958; Alexopoulos 1975). Otherwise, our specimen would match *T. affinis*, which seems to be the most common of all three species in the Neotropics. The spore-mass is lemon-yellow, spores are very pale yellow, 13–15 μm diam., coarsely banded-reticulate with 3–5 meshes covering one hemisphere, the reticulation consisting of sometimes interrupted, but mostly complete ridges up to 1 μm high.

Tubifera microsperma [O] (Berk. & M.A. Curtis) G.W. Martin (***MCF***: 2 – wood), Figs. 15–16. – AG, CU, DM, JM, PR.
Lit.: Farr 1976; Lodge 1996; BPI, CUP, NY.

RESULTS AND DISCUSSION

The present survey yielded a total of 221 records; 44 species belonging to 19 genera were identified. Four species were obtained from plasmodia collected in the field. Eight species are new records for Puerto Rico, raising the total number of species known from the island to 98.

At least four of the species recorded in this survey appear to be restricted to tropical and subtropical areas. These are *Ceratiomyxa morchella*, *C. sphaerosperma*, *Craterium paraguayense*, and *Tubifera microsperma*. *C. paraguayense* is reported mainly from tropical and subtropical lowland areas, but seems to extend into montane regions such as the oak and fir vegetation belts of the Mexican volcanoes (Hernandez-Cuevas et al. 1991). The majority of the species reported in this paper seem to have a wider distribution, but are more abundant in tropical and subtropical regions, as it is the case for most of the reported species of *Physarum*. Noteworthy is the apparent absence or rarity of a number of species common in temperate regions. Among these are *Trichia varia* (Pers.) Pers. and *Fuligo septica* (L.) F.H. Wigg. (not observed during this study), as well as *Trichia favoginea*, *Metatrichia vesparium*, and *Physarum viride* (each represented by only a single record).

Among the forest types studied, almost no myxomycetes were collected from those types located at the two extremes of the moisture gradient (the mangrove forest with an influence of tidal water – 6 records, and the dry coastal forest – no records). However, substrate samples from the dry coastal forest type revealed a surprisingly rich biota of myxomycetes when studied with the moist chamber method (Rollins, unpubl. data). The moist coastal forest (17 records and 9 species) showed a higher myxomycete diversity, although 8 records belong to a single species (*Oligonema* cf. *flavidum*).

Within the investigated forest types in the Luquillo Mountains, a clear pattern of decreasing myxomycete diversity with increasing elevation was observed: tabonuco forest (150–400 m elev.; 144 collections and 37 species), palo colorado forest (600–750 m elev.; 48, 15), palm forest (650–750 m elev.; 6, 5), and elfin forest (>750 m elev.; 7, 6). Studying litter-inhabiting myxomycetes with the moist chamber method, Stephenson et al. (1999) also reported the lowest myxomycete diversity in the elfin forest. Field collections and moist chamber records from an elevational gradient in the Western Andes of Ecuador (M. Schnittler et al., unpubl. results) as well as a study from Costa Rica (Schnittler & Stephenson 2000) seems to substantiate this pattern even further. As discussed in the latter paper, the continuously high humidity of montane tropical forests provides rather unfavorable conditions for myxomycete development. However, our results in the Luquillo Mountains refer to one season only. To ensure the recording of all phenological groups and to estimate all species diversity in the Luquillo Mountains, evidently more than one field survey in a year is necessary.

Within this survey, decaying wood (22 species, representing 46% of all collections) was the most productive substrate type, followed by leafy litter (25 species, 35%). Palm litter was less productive, but still yielded 8 species (11% of all collections). Both bark and aerial litter each yielded only a few field collections. On the other hand, the latter substrate type was productive in moist chamber cultures (A. Rollins, unpubl. results). From the 22 myxomycete species collected from wood, 18 occurred exclusively on this substrate type. Myxomycetes collected from litter (25 species recorded) were less specialized; only 16 species were found to be restricted to this substrate type. However, *Didymium iridis* (21 collections) and *Physarum melleum* (12 collections), the two most common litter-inhabiting species, were specialists for this substrate. The tabonuco forest, located at the lower end of the elevational gradient, was especially rich in litter-inhabiting myxomycetes. Productive sites were those numbered 5, 6 and 10 in Fig. 1; with myxomycete assemblages dominated by huge colonies of *D. iridis* on leaf litter and *Ceratiomyxa sphaerosperma* on dead decaying fruits of *Andira inermis*. One surprising observation was the affinity of *Ceratiomyxa sphaerosperma* for decaying fruits. Studies in the Amazonean part of Ecuador confirmed the close association of this species with fruit shells (Schnittler, unpubl. results). Possibly the richer nutrient content of the fruits attracted soil bacteria and in turn benefited the myxomycete. Palm litter supported only a few myxomycete species, with *Hemitrichia serpula* as the only species that seems to have a preference for this substrate (4 of the 6 collections of this species).

Almost all of the 98 species of myxomycete hitherto known from Puerto Rico are based upon field collections. Extensive studies using the moist chamber method will undoubtedly add more species to this list, as indicated the study conducted by Stephenson et al. (1999), which was based on 500 litter samples cultivated in moist chambers.

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LASIOLOMA STEPHANELLUM COMB. NOV. (LICHENIZED ASCOMYCETES: ECTOLECHIACEAE)

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Abstract: The new combination *Lasioloma stephanellum* (Nyl.) R. Lücking & Sérus. (Bas.: *Lecidea stephanella* Nyl.) is introduced for a rare corticolous species known from three collections gathered in Cuba (type), Brazil: Pernambuco, and Togo. A key to all known species of *Lasioloma* is provided.

Key Words: Ectolechiaceae —*Lasioloma* — Neotropics and Africa

Introduction

Within the Ectolechiaceae, the genus *Lasioloma* R. Sant. is distinguished by a dispersed to rarely continuous, smooth or irregular thallus, with a loosely woven, usually well-developed prothallus, margins of apothecia with hairs formed of thick-walled hyphae, a paraplectenchymatous excipulum, richly branched and anastomosed paraphyses, and campylidia of the *Pyrenotrichum splitgerberi*-type, producing filiform and transversely septate conidia with 2-4 long branches originating from a single point (VEZDA 1986; LÜCKING 1999; see Tab. 1). So far the genus includes six foliicolous taxa. Only one species has a pantropical distribution, while a center of diversity is found in S-E Asia, with four endemic species.

For several years we have been aware of a further species, which is corticolous and known from only two collections. While working on the neotropical corticolous representatives of the Ectolechiaceae, mainly *Calopadia* Vezda, we came across a forgotten epithet which turned out to represent this taxon. The necessary combination is made in this paper and we further provide an up-dated key to all species of the genus.

Relevant information on the genus can be found in SANTESSON (1952:545-551) for the original and detailed description of the genus and four species; SÉRUSIAUX (1986) and VEZDA (1986) for the description of the campylidia and conidia; VEZDA (1994: 134-136) for the original description of *L. spinosum*; APTROOT & al. (1997: 73-75) for details on the separation of *L.*

arachnoideum from *L. phycophilum*; and finally SANTESSON & LÜCKING (1999: 729-730) for the original description of *L. inexspectatum*.

Lasioloma stephanellum (Nyl.) R. Lücking & Sérus. comb. nov.

Basionym: *Lecidea stephanella* Nyl., Flora 49: 291 (1866). *Lopadium stephanellum* (Nyl.) Zahlbr., Cat. Lich. Univ. 4: 314 (1926). – Type: Cuba, without any indication on locality, date of collection nor identity of the collector (H-Nyl 18098!).

Description: Thallus warted, entirely made of densely or rather loosely compact verrucae which are whitish but with a faint yellowish green hue, 0.1-0.2 mm in diam. and c. 0.1 mm in height, and sometimes coalescing; medulla pale yellow to reddish when old. **Prothallus** abundant between the verrucae, and sometimes on the outer edge of the thallus, white or very pale grey, made of densely interwoven, 4-7 µm thick hyphae, with thick walls; outer parts of the prothallus typically made of dark blue hyphae. **Photobiont** a species of the Chlorococcaceae, most probably *Trebouxia*. **Cyanobacteria** always present on the prothallus, not clearly associated with hyphae, belonging to the Scytonemataceae (probably a species of *Scytonema*), forming dark blue or almost black patches.
Apothecia lecideoid, rounded or slightly irregular, 0.3-0.5 (-0.6) mm in diam., constricted at their base, disc plane or slightly convex, pale greyish to dark grey, or almost black, with a faint violet or bluish hue, non pruinose, margin paler than the disc, with densely and irregularly arranged (but sometimes almost absent), whitish or pale grey hairs which do not exceed 50-80 µm long. **Excipulum** hyaline or almost so, typically paraplectenchymatous, 40-70 µm thick; **hypothecium** dark brown, +/- aeruginose in central parts, up to 50 µm thick; **hymenium** hyaline, c. 100 µm thick; **paraphyses** abundant, branched and anastomosed; **asci** clavate, of the *Sporopodium*-type; **ascospores** single in the asci, strongly muriform, ellipsoid, 70-85 x 22-24 µm.
Campylidia not found.

Notes: Although campylidia have not been found, there is no doubt that this taxon belongs to *Lasioloma* as circumscribed by SANTESSON (1952), as all features match perfectly. The warted thallus entirely made of verrucae is diagnostic for the species, as well as the corticolous habit. *Lasioloma stephanellum* could be related to *L. phycophorum* and *L. trichophorum* as they all have a yellowish medulla. TLC analysis has not been performed but it has been suggested (APTROOT & al. 1997: 75) that the yellowish pigment is identical to that found in *Sporopodium lucidum*.

It is interesting to note that a verrucose to almost isidioid thallus is very rare and untypical in foliicolous representatives of the Ectolechiaceae but has been found in several corticolous representatives of *Calopadia* (e.g. *C. isidiosa*) and *Sporopodium* (two undescribed species from tropical Asia). Since most of the typically corticolous species of *Calopadia* (e.g. *C. lecanorella*, *C. perpallida*) do have a smooth thallus, we do not consider the verrucose-isidioid thallus an ecological modification but an ecomorphological feature that is specific.

Distribution and ecology: *Lasioloma stephanellum* is known from Cuba (type locality), from the N-E coast of Brazil in Pernambuco, where it was growing at the base of a small tree by an artificial lake in a highly disturbed remnant of the 'Mata Atlãntica', and in Togo, in unknown ecological conditions.

Additional specimens examined: AMERICA: **Brazil**, Pernambuco, Caljibe Co, Aldeia, c. 20 km W of Recife, alt. 60 m, disturbed rainforest (Mata Atlãntica), VI.1996, R. Lücking & E. Sérusiaux s. n. (LG). AFRICA: **Togo**, distr. Kluto-Palimé, 6°54'N 0°37'E, Hanyigba-Dugã, alt. c. 300 m, IX.1974, A. Mathey (B).

Key to the known species of *Lasioloma*

1a Asci with more than one spore; apothecial hairs conspicuous or not; foliicolous species ... **2**
1b Asci with a single, muriform spore; apothecial hairs always conspicuous; foliicolous or corticolous species ... **3**

2a Ascospores 8/ascus, 7-septate; apothecia with inconspicuous hairs; Africa (Ivory Coast) ... ***Lasioloma inexspectatum* R. Sant. & R. Lücking**
2b Ascospores (2-)4/ascus, (sub-)muriform; apothecia with conspicuous, rather stiff hairs; Asia (Indonesia: Java) ... ***Lasioloma spinosum* Hafellner & Vezda**

3a Thallus warted, entirely made of densely or rather loosely compact verrucae; medulla pale yellow to reddish when old; corticolous species; Neotropics (Brazil: Pernambuco, and Cuba), and W Africa (Togo) ... ***Lasioloma stephanellum* (Nyl.) R. Lücking & Sérus.**
3b Thallus not made of verrucae; foliicolous species ... 4

4a Thallus continuous or with dispersed and irregular patches, especially near the margins, with an abundant fluffy prothallus between the patches or spreading over the thallus surface, and forming abundant vermicular cephalodia; Asia (Philippines: Luzon, Papua New Guinea, New Caledonia) ... ***Lasioloma phycophilum* (Vain.) R. Sant.**
4b Thallus typically made of dispersed patches; prothallus produced between the patches; cephalodia present or not ... 5

5a Thallus made of rounded, flat patches, with a crenulate margin and a greenish grey, rather glossy surface; medulla whitish or almost so; cephalodia never produced; pantropical and ubiquitous ... ***Lasioloma arachnoideum* (Krempelh.) R. Sant.**
5b Thallus made of irregular and rather convex patches, with a crenulate to irregular margin and a yellowish green, typically glossy surface; medulla pale to bright yellow; cephalodia present on the prothallus; species restricted to S-E Asia ... 6

6a Apothecial disc dark brown to blackish; Asia (Malaysia: Sarawak, Philippines: Luzon and Mindanao, New Caledonia) ... ***Lasioloma phycophorum* (Vain.) R. Sant.**
6b Apothecial disc pale brown; Asia (Philippines: Luzon, Papua New Guinea, New Caledonia) ... ***Lasioloma trichophorum* (Vain.) R. Sant.**

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LICHENICOLOUS FUNGI, MAINLY FROM THE USA, INCLUDING PATRICIOMYCES gen. nov.

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Abstract: 53 species of fungi growing on lichens are reported from the United States, 10 from Canada, 1 each from Baja California, Mexico, Taiwan, and the U.K. Of these 20 are reported for the first time, and most others are new state records. *Abrothallus tulasnei* sp. nov., *Laeviomyces lecanoricola* sp. nov., *Nectriopsis cladoniicola* sp. nov., *Opegrapha wetmorei* sp. nov., *Paranectria oropensis* subsp. *parvispora* subsp. nov., *Patriciomyces valentinianus* gen. sp. nov., *Taeniolella caespitosa* sp. nov. and *T. laevistipitata* sp. nov. are described as new to science. The new combinations *Nectriopsis parmeliae* (syn. *Diplodina parmeliae*) and *N. rubifaciens* (syn. *Nectria rubifaciens*) are also made. Observations are included on some of the more interesting finds, including *Homostegia parmeliana* previously only reported from the Russian steppes. An analysis of ascospore and conidial sizes of *Abrothallus* collections on parmelioid lichens led to the recognition of *A. microspermus* on *Flavopunctelia* and *Punctelia* as well as *Flavoparmelia* and *Parmotrema.* A key to the four known *Laeviomyces* species is also included.

Keywords: Ascomycetes, coelomycetes, hyphomycetes, lichens

INTRODUCTION

The fungi obligately growing on lichen thalli are proving to be a major source of unexplored fungal diversity. The number of these fungi known world-wide has risen from 457 in 1976 to 894 in 1996, an increase of 96 % in 20 years (Hawksworth & Rossman, 1997).

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Apart from a few significant early studies, notably those of Willey (1892) and Fink (1935), little interest in these fungi had been shown in the United States until the 1990s. The first major publication was that of Triebel, Rambold & Nash (1991) who reported 58 species from continental North America, 27 for the first time and including two new to science. Following that stimulus, these fungi have been incorporated into recent checklists (e.g. Esslinger & Egan, 1995) and many site or state inventories. Much still awaits discovery in North America generally, as evidenced by the report of 63 species, including one genus and seven species new to science from British Columbia from excursions made in association with the Fifth International Mycological Congress in Vancouver in 1994 (Alstrup & Cole, 1998).

The present contribution represents the first study on lichenicolous fungi in the midwest United States, primarily based on collections made by the first author, supplemented by material from the rich collections of C.M. Wetmore in MN and other sources which have come to our attention. Data from some collections made by the first author in Quebec are also included, and one fungus reported had also been discovered by the second author in Taiwan and the UK. Unless noted otherwise, the specimens discussed here will be found in MIN.

COLLECTION SITES

Arkansas (AR)
Franklin County: Ozark National Forest, Cherry Bend Campground along Ark. Highway 23. 35°44'36"N, 93°48'42"W.

California (CA)
Santa Barbara County: Santa Barbara Island, Channel Islands National Park, trail to North Peak. 33°28'48"N, 119°01'50"W. Ventura County: A. San Nicolas Island, Channel Islands National Park, south side, below Twin Towers at edge of bluff. 33°14'36"N, 119°31'22"W. B. San Nicolas Island, bottom of Theodolite Road, north side of island. 33°14'36"N, 119°31'22"W.

Maine (ME)
Hancock County: Acadia National Park, Mt. Desert Island, Eagle's Crag (0.75 mi. NW of Otter Creek). 44°19'31"N, 68°13'11"W.

Massachussetts (MA)
Franklin County: in residential area. 42°11'15"N, 71°26'15"W. Middlesex County: town of Lynnfield. 42°33'45"N, 71°3'45"W.

Michigan (MI)

Keweenaw County: Isle Royale National Park. Rock Harbor on main island W. of Davidson Island just east of 3 mile campground. 48°7'22"N, 88°31'11"W.

Minnesota (MN)

Carlton County A. yard in residential area, Esko MN. 46°42'25"N, 92°21'44"W.B. Duluth-Hinckley Bicycle Trail, 3/4 mile west of Thompson, MN. 47°7'36"N, 96°47'50"W. Clay County: City park at north edge of Ulen (28 miles NE of Moorhead), above South Branch of Wild Rice River. 47°5'11"N, 96°15'31"W. Clearwater County: A. Itasca State Park, off Bohall Trail. 47°12'N, 95°15'W. B. Lake Itasca Biological Station, University of Minnesota. 47°45'40" N, 91°47'35"W. C. In ravine off Okerson Heights Trail, near Budd Lake. 47°9'50"N, 95°10'20"W. Cook County- Boundary Waters Canoe Area: A. Jasper Lake. 48°7'30" N, 91°2'20"W. B. Tuscarora Lake. 48°2'37"N, 90°53'2"W. C. Seagull Lake. 48°8'48"N, 90°52'12"W. D. Winchell Lake. 47°59'36"N, 90°35'24"W. E. Cherokee Lake, island in the middle of the lake. 47°57'49"N, 90°48'5"W. F. Muskeg Lake, campsite on peninsula in the middle of the lake. 47°59'20"N, 91°40'59"W. G. Portage from Powell Lake to French Lake. 48°3'48"N, 90°57'18"W. H. Portage from Lake Gabimichigami at the west end of Peter Lake. 48°3'58"N, 90°59'56"W. Hubbard County: Itasca State Park, Twin Lakes, east of Main Park Drive in the south part of the park. 47°10'30" N 95°10'00"W. Lake County: A. Eddy Lake. 48°6'30" N, 91°10'20"W. B. Knife Lake. 48°5'49"N, 91°10'10"W. C. South Arm Knife Lake. 48°7'30" N, 91°2'20"W. D. North of Birch Lake campground, 9 miles south of Ely MN. 47°45'40" N, 91°47'35"W. Mahnomen County: nine miles east of Mahnomen, one mile south of Highway 200. 47°17'56"N, 96°8'6"W. Mille Lacs County: Kathio State Park. 46°12'30" N, 93°46'30"W. St. Louis County A. Voyageurs National Park, Fox Island in Rainy Lake. 4836'50"N, 93°2'37"W. B: Just north of Pfeifer Lake (9 mi SW of Tower). 47°45'24" N, 92°27'56"W. C. Skibo Mill, 10 miles southeast of Hoyt Lakes near St. Louis River. 47°28'7"N, 91°56'26"W. D. East of Bassett Lake, south of Highway 16 (21 miles SE of Hoty Lakes). 47°22'23"N, 91°51'25"W.

Missouri (MO)

Carter County: Peck Ranch Conservation Area, vicinity of Stegall Mountain fire tower and knob northwest of tower, ca. 1.8 miles north of Peck Ranch Road. 37°4-5'30" N, 91°12'W. Douglas County: Mark Twain National Forest, in lower portion of Dimcher Hollow ca. 3.5 miles east of Indian Creek along north side of Hwy 76. 36°58'N, 92°07'W. Oregon County: Mark Twain National Forest, McCormack Lake Recreation Area, in lower portion of McCormack Hollow and adjacent Gasconade Dolomite bluff along north side of Eleven Point River east of McCormack Hollow, south of McCormack Lake. 36°48-49'N, 91°21'W. Ozark County: Mark Twain National Forest, along Glad Top Trail, on south-facing Cotter Dolomite glad between Bristle Ridge and Sugar Tree Hollow, ca. 3.8 air miles south of Smallett. 37°47'N, 92°43'W. Reynolds County: Johnson Shut-Ins State Park, along East Fork Black River, east of Hwy N; in vicinity of main shut-ins. 37°32'N, 90°50'W.

Nebraska (NE)
Sioux County: Agate Fossil Beds National Monument, 1 mile west of Carnegie Hill on south side of road, on bluff at north end of ridge with little hard rock cap. 42°24'60"N, 103°44'51"W.

North Carolina (NC)
Buncombe County: Pisgah National Forest, near intersection of SSR3484 and Rd. 481 off Hwy 191, near NC Arboretum outside of Asheville. 35°29'45"N, 82°36'54"W.

North Dakota (ND)
Mercer County: Knife River Indian Villages National Historic Site, north edge of park 0.5 mi north of small road east on Missouri River lowlands (54 miles NW of Bismarck). 47°21'42"N, 101°23'03"W.

Wisconsin (WI)
Sauk County: Spring Green Preserve, oldfield sand prairie with scattered limestone, northwest of Spring Green off of Highway 14. 43°12'N, 90°04'W.

Wyoming (WY)
Park County: Yellowstone National Park. A . Pebble Creek Trail at rocks above cliffs, below switchback, 0.025 mile up from campground. 44°55'19"N, 110°06'38"W. B. 2 miles north of Fishing Bridge, on northwest slope above small valley. 44°35'19"N, 110°23'14"W. Teton County: Yellowstone National Park, below Mystic Falls near Biscuit Basin, on north facing slope above stream. 44°28'57"N, 110°52'40"W.

Baja California, Mexico
Punto Santo Tomas SW of Ensenada, on north point along ridge and on rocks above the ocean. 31°33'20"N, 116°41'20"W.

Quebec, Canada
All specimens collected during the 1997 ABLS Excursion. Québec County: Station 1.1: Stoneham; Mont Wright Parc de Conservaton Municipal. 47°00'42"N, 71°20'45"W. Montmorency no 1 County; Réserve Faunique des Laurentides; Station 2.2 Forêt Montmorency; Chute de la rivière Noire. 47°16'13"N, 71°9'51"W. Station 2.4: Lac Barrette, west of Road 175. 47°27'20"N, 71°14'45"W. Station 2.5: Lac Barrette, Road 175 near the road to Parc des Grands Jardins; hydroelectric line along the road. 47°38'16"N, 71°12'17"W. Charlevoix-Est County: Station 3.2 Centre Ecologique de Port-au-Saumon; Habenaria trail, shoreline rocks, maritime influence from St. Lawrence estuary. 47°45'30"N, 69°57'00"W.

SPECIES RECORDED

Abrothallus bertianus De Not. 1849

On *Cetraria sepincola*, Keewenaw Co., MI, *Wetmore 47269.*

Abrothallus cladoniae R. Sant. & D. Hawksw. 1990

On *Cladonia cfr. peziziformis*, Ozark Co. MO, *Cole 7539.*

Abrothallus microspermus Tul. 1852

On *Flavoparmelia caperata,* Clearwater Co. MN A, *Cole 1735, 1736, 1729, 1729 dupl.*, Clearwater Co. MN B, *Cole 3093*, Clearwater Co. MN C, *Dzurenko 7*, Cook Co. MN A, *Cole 7626*, Cook Co. MN B , *Cole 1863*; on *Flavopunctelia flaventior*, Mille Lacs Co. MN, *Cole 6076*; on *Flavopunctelia soredica*, Hubbard Co. MN, *Cole 4028 B*, Mille Lacs Co. MN, *Cole 6048, 6048 dupl., 6052, 6052 dupl., 6054, 6056, 6056 dupl., 6057*; on *Punctelia rudecta*, Hancock ME, *Sullivan 2299*, Cook Co. MN A, *Cole 7622*; Carter Co. MO, *Cole 7358, 7541.*

New to North America.

Observations: Extensive material of *Abrothallus,* and also of *Vouauxiomyces* anamorphs, was present in collections of *Flavoparmelia* and *Flavopunctelia,* and other material was present on *Punctelia* and *Xanthoparmelia* species. In order to ascertain the extent to which this material belonged to the same species, series of measurements were made of the ascospores and conidia. The results, presented in Table 1, suggest that all the collections apart from that on the *Xanthoparmelia* belonged to a single morphospecies. *Abrothallus microspermus* was originally described as having ascospores 9.5-11 x 3.2-4.8 µm and conidia 6.5 x 3.5 µm (Tulasne, 1852), somewhat smaller than in the North American material; however, Clauzade, Diederich & Roux (1989) give the ascospores as 9-14 x 3-5.5 µm, broadly in agreement with our results. The conidia of the anamorph, *Vouauxiomyces truncatus* (de Lesd.) Dyko & D. Hawksw. 1979, were given as 6.5-8.5 x 4-5.5 µm by Hawksworth & Dyko (1979) and so fall in the range of the richer North American material.

As many *Abrothallus* species are restricted to particular host genera, it is of especial interest that *A. microspermus* is apparently able to grow on *Flavoparmelia, Flavopunctelia,* and *Punctelia*; it has also been reported on *Parmotrema* in the UK (S. Devon: Slapton Ley National Nature Reserve, The Causeway, on *P. chinense* on *Salix,* 30 March 1972, *Hawksworth 2696 p.p.,* IMI 164972, UPS). The teleomorph *Abrothallus microspermus* has not been published from North America before, although the anamorph *V. truncatus* was reported by Triebel *et al.* (1991).

Abrothallus peyritschii (Stein) I. Kotte 1909

On *Vulpicida pinastri*, Cook Co. MN F, Cole 6074, Quebec Station 2.2, *Cole 7126*; Quebec Station 2.4, *Cole 7141*.

Abrothallus tulasnei M. S. Cole & D. Hawksw., **sp. nov.**

Etym.: In honour of Louis-René Tulasne (1815-1885) who first recognized the link between *Abrothallus* and its anamorph, later named *Vouauxiomyces*.

Figure 1

Apothecia convexa, nigra, non pruinosa, non stipitata, (160-)175-225(-250) µm. Ascosporae brunneae, 2-septatae, verruculosae, 15-17 x 7-11 µm. Pycnidia (50-)62-100 (-125)µm diameter. Cellulae conidiogenae 7-11 x 3.5-4.5 µm. Conidia anguste obpyriformia, hyalina, simplicia, (9.5-)11-14.5(-19) x (3.5-)4-5(-6.5) µm.

Holotypus: Canada: Quebec: Charlevoix-Est Co., Centre Ecologique de Port-au-Saumon, Habenaria trail, 47°45'30"N, 69°57'00"W, on *Xanthoparmelia somloënsis* apothecia and thallus on shoreline rocks, 9 August 1997, *Cole 7243* (MIN).

Apothecia arising singly, scattered, superficial, convex, not stipitate, normally not constricted at the base, but rare old apothecia sometimes occasionally somewhat constricted below, black, dull, not pruinose even when young, (160-)175-225(-250) µm diameter; vegetative hyphae immersed in the host tissues, not turning blue in iodine. *Exciple* absent. *Hymenium* olivaceous-green in potassium hydroxide, particularly intense towards the base, 65-85 µm tall; epithecium granular, olivaceous green in potassium hydroxide, mainly 5-8 µm tall; hypothecium well-developed, dark brown, 90-120 µm tall, composed of irregularly angular cells 9-12.5(-16) µm. *Paraphyses* richly branched, repeatedly septate, anastomosing, mainly 2.5-3 µm thick, the tips abruptly swollen but not thickened, olivaceous green in K and to 3.5-4.5 µm across. *Asci* elongate-clavate to subcylindrical, 50-57 x 15.5-18.5 µm, 8-spored. *Ascospores* overlapping in the ascus, broadly ellipsoid, 1-septate, slightly constricted at the septum, dark brown, coarsely warted, 15-17 x 7-11 µm.

Pycnidia arising singly, scattered, mainly superficial but immersed at the base, subglobose, somewhat flattened around the often gaping ostiole, black, (50-)62-100(-125) µm diameter; pycnidial wall composed of radially compressed polyhedral pseudoparenchymatous cells (*textura angularis*), 2-3 layers of cells thick, cells dark-brown, walls unevenly thickened, 7-11 µm diameter. *Conidiogenous cells* ampulliform, hyaline, holoblastic, proliferating apically with 0-3 annellations, 7-11 x 3.5-4.5 µm. *Conidia* arising singly, narrowly obpyriform, truncated at the base, simple, hyaline, distinctly minutely warted, (9.5-)11-14.5(-19) x (3.5-)4-5(-6.5) µm.

Host: *Xanthoparmelia somloënsis* apothecia and pycnidia, occurring on both the thallus and apothecial discs of the host. Not associated with galls, and apparently commensalistic, the normal yellow-grey colour of the thallus being retained. The holotype collection is also infected with what may well be *Echinothecium reticulatum* Zopf 1898, but no ascospores were found.

Observations: An *Abrothallus* on *Xanthoparmelia conspersa* was included under the name *A. parmeliarum* (Sommerf.) Arnold 1874 by

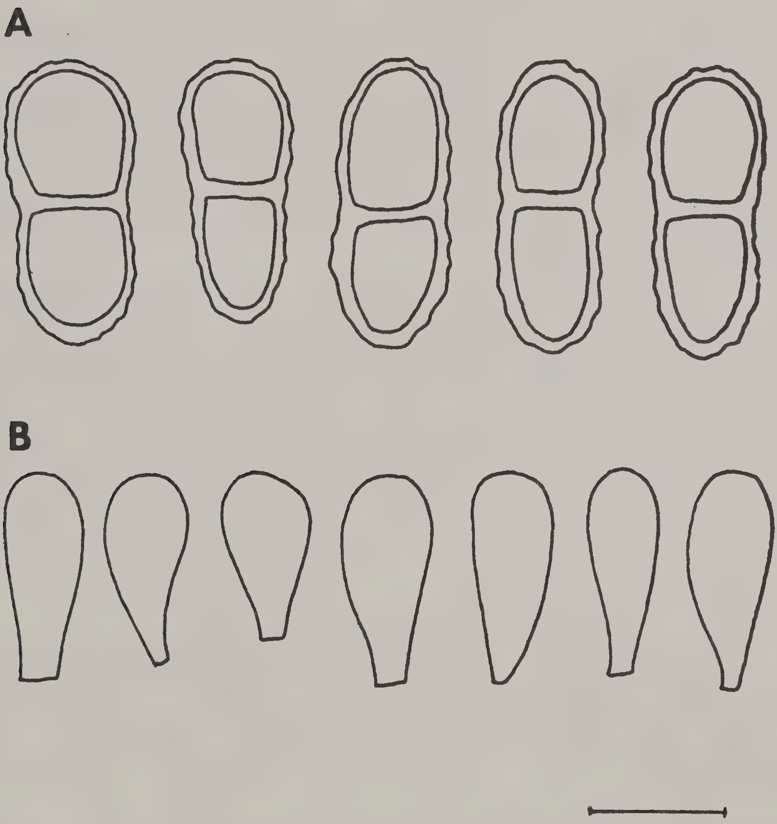

Figure 1. *Abrothallus tulasnei* (*Cole 7243*, MIN- holotype). A, Ascospore outlines. B, Conidia. Scale = 10 µm.

Vouaux (1912). We haven't seen Vouaux's material, but *A. parmeliarum* has apothecia which are iridescent green-pruinose when young and is confined to *Parmelia* s. str. The Quebec collection is non-pruinose, but differs from the non-pruinose *A. microspermus* in the much wider ascospores and narrower *Vouauxiomyces* conidia (Table 1). Further, the reaction of the hymenium with potassium hydroxide is distinctly olivaecous green rather than the bluish green found in *A. microspermus.* This species has such a distinctive suite of characters that we have no hesitation in describing it as new.

Abrothallus usneae Rabenh. 1845

On *Usnea fulvoreagens*, Cook Co. MN E, *Cole 4061dupl.*

Confirmed for North America.

Observations: Esslinger & Egan (1995) indicated that North American records of this species referred to *Lichenostigma maureri* Hafellner 1982. However, that fungus differs from *Abrothallus* in that the ascomata are not apothecia but a compact pseudothecium without paraphyses; further the ascospores in *L. maureri* measure 9-12 x (4-)4.5-6 µm. The ascomata of *Lichenostigma maueri* are 70-120 x 30-40 µm according to Hafellner (1982), whereas in *Abrothallus usneae* they are much bigger, often exceeding 300 µm across.

The Minnesota collection of *A. usneae* conforms to the description and illustrations of Galløe (1950), who did not provide spore measurements of the ascospores. The ascospores are cited as 14-18 x 5-7 µm by Clauzade, Diederich & Roux (1989), and 10-14 x 4 µm by Jatta (1909). In the Minnesota material the ascospores are significantly smaller, consistently measuring 11 x 4.5 µm. and the ascomata average 280 µm. across. In the absence of information on the dimensions in the type material, we nevertheless feel it appropriate to adopt this name pending more critical studies on the genus.

Arthonia glaucomaria Nyl. 1856

On *Lecanora rupicola* group, Park Co., WY, *Wetmore 81433.*

Observations: The continued use of this name rather than the less familiar *A. varians* (Davies) Nyl. 1861, which was taken up by Purvis *et al.* (1992), depends on the typification of Davies' epithet by the host lichen not the lichenicolous fungus, as proposed by Santesson (1993) but not yet effected.

Arthonia molendoi (Heufl. ex Frauenf.) R. Sant. 1986

On *Caloplaca luteominia*, Ventura Co. CA A, *Bratt 7864.*

Host Species	Specimens	Spores measured	Length	Breadth	Length/ breadth
Abrothallus					
Flavoparmelia caperata	1	10	12-**13.17**-14.5	4-**4.6**-5.5	2.86
Flavopunctelia soredica	5	44	10-**13.91**-15.5	4.5-**4.65**-8.0	2.32
Punctelia rudecta	2	20	13-**14.68**-16.5	4.5-**5.56**-6.3	2.64
Xanthoparmelia somloënsis	1	12	15-**16.07**-17	7-**8.01**-11	2.01
Total	9	86			
Vouauxiomyces					
Flavoparmelia caperata	5	51	5.5-**8.27**-12	3-**4.17**-6.5	1.98
Flavopunctelia flaventior	1	7	7-**7.69**-8	4.5-**4.68**-5.5	1.64
Flavopunctelia soredica	8	74	6-**7.57**-10	4-**5.16**-6	1.46
Punctelia rudecta	2	20	7.5-**9.17**-12	4.5-**5.44**-6	1.68
Xanthoparmelia somloënsis	1	20	9.5-**12.32**-19	4-**4.58**-6	2.72
Total	16	152			

Table 1. A comparison of the sizes and shapes of the ascospores and conidida of collections of *Abrothallus* and *Voauxiomyces* anamorphs on selected hosts. Figures in **bold** are arithmetic means.

Bispora christiansenii D. Hawksw. 1979

On *Caloplaca trachyphyllina*, Sioux Co. NE, *Wetmore 77785*.

New to North America

Bispora lichenum Diederich 1990

On *Evernia mesomorpha*, Cook Co. MN A, *Cole 7616*.

New to North America.

Buellia imshaugii Hafellner 1979

On ? *Dimelaena* sp., Carter Co. MO, *Cole 7454, Cole 7463*.

Observations: The identification of the host is uncertain: it does not represent one of the yellow green species usual in the region.

Clypeococcum hypocenomycis D. Hawksw. 1980
On *Hypocoenomyces scalaris*, Carlton Co. MN B, *Cole 6137.*

Cornutispora ciliata Kalb 1993
On *Melanelia septentrionalis*, Quebec Station 3.1, Cole 7194.
New to North America.

Cornutispora lichenicola D. Hawksw. & B. Sutton 1973
On *Flavoparmelia soredica,* Carlton Co. MN A, *Cole 1901,* on *F. flaventior*, Carlton Co. MN B, *Cole 6078.*

Dactylospora parasitica (Flörke ex Spreng.) Zopf 1896
On *Pertusaria* sp., St. Louis Co. MN B, *Wetmore 82348.*

Endococcus perpusillus Nyl. 1857
On *Porpidia albocaerulescens*, Reynolds Co. MO, *Cole 7506*

Observations: This species is close to *E. exerrans* Nyl. 1879, but as noted by Triebel (1989) it differs in the more narrowly subcylindrical to narrowly ellipsoidal ascospores, differing markedly in the length:breadth ratios. She gave the ascospores of *E. exerrans* as 11-14 x 3-4(-5) µm based on the holotype in H (H-NYL 515); however, the range of ascospores was found to be (12-)14-18(-20) x 3.5-5(-6) µm in an isotype in K (Hawksworth, 1979b), accentuating the reported shape differences. In the Minnesota collection the ascospores were 11-15.5 x 5.5-6.5 µm, falling in the range for *E. perpusillus.*

Endococcus propinquus (Körb.) D. Hawksw. 1979
On *Porpidia speirea,* Quebec Station 3.2, *Cole 7231.*

Epicladonia sandstedei (Zopf) D. Hawksw. 1981
On *Cladonia rei*, St. Louis Co. MN C, *Wetmore 30165.*

Epicladonia simplex D. Hawksw. 1981
On *Cladonia apocarpa*, Sauk Co. WI, *Cole 7629.*

Homostegia parmeliana (Jacz.) Vouaux 1912
On *Flavoparmelia caperata,* Franklin Co. AR, *Wetmore 14058..*
Figure 2
New to North America

Observations: The Arkansas material agrees in most respects with the original description of this little-known species, first described from the

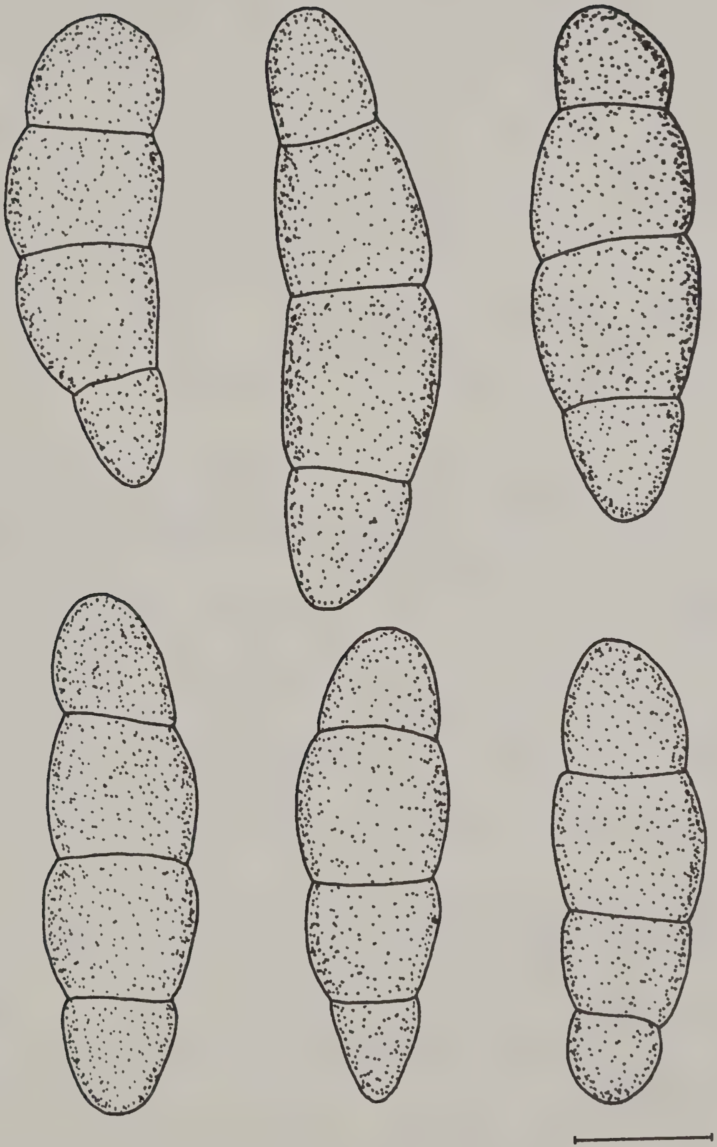

Figure 2. *Homostegia parmeliana* (*Wetmore 14058*, MIN). Ascospores. Scale = 10 µm.

Russian steppes growing on a yellow-green parmelioid lichen then named as '*Parmelia molliuscula* var. *vagans'*, i.e. *Xanthoparmelia vagans.* Clauzade, Diederich & Roux (1989) mention it on *X. somloënsis* and *X. tartaractica* but the source of their records was not indicated. However, while ascospore sizes appear to agree, being given as 30 x 6-8 µm in the original account and measured as 28-36.5 x 7-9(-12) µm in the Arkansas material, Jaczewski (in Elenkin 1901a: 22) stated that the ascospores were subhyaline to yellowish. Interestingly, while some ascospores drawn and figured by Elenkin are almost hyaline, some included in an ascus appear to be pigmented in the published figure (Elenkin, 1901b: 146, fig. 5b); those of the Arkansas material were subhyaline at first but smoky brown to dark brown when mature. The species differs from *H. piggotii*, which occurs on *Parmelia* s. str., in the longer and somewhat narrower dimensions of the ascospores. As the Russian and Arkansas collections are on different yellow-green parmelioid lichens and the environments differ, a comparison with the type would be valuable but this could not be accomplished in the time we had available for this study.

The citation of the basionym of this name has been confused in the lichenological literature, probably due to difficulties in accessing copies of early Russian publications. The fungus was actually first validly published as *Trematosphaeria parmeliana* by Jaczewsky in a footnote in Elenkin (1901a: 22); the name was attributed to Jaczewsky alone, and a Latin description is provided in quotation marks- making it clear this was Jaczewsky's text. In accordance with Art. 46 Note 1, the author has to be cited simply as "Jacz." and not "Jacz.. ex Elenkin" nor "Jacz. in Elenkin". The cause of confusion has been that when Elenkin (1901b:146) introduced the new genus *Trematosphaeriopsis*, he attributed it to "nov. sp. Jaczewski) Elenkin" suggesting that the species was being described at the same time. However, that this was not the case is evident from Elenkin (1901b:136) where there is a reference to the Elenkin (1901a) paper with a page number cited- clearly indicating that this came out earlier in 1901 than Elenkin (1901a).

Homostegia piggottii (Berk. & Broome) P. Karst. 1873
On *Parmelia saxatilus*, Hancock Co. ME, *Wetmore 5502*; on *Parmelia sulcata*, Quebec 1.1, *Cole 7054.*

Laeviomyces lecanoricola M. S. Cole & D. Hawksw., **sp. nov.**
Etym.: *Lecanor*(*-a*)-icola (dwelling).
Figure 3

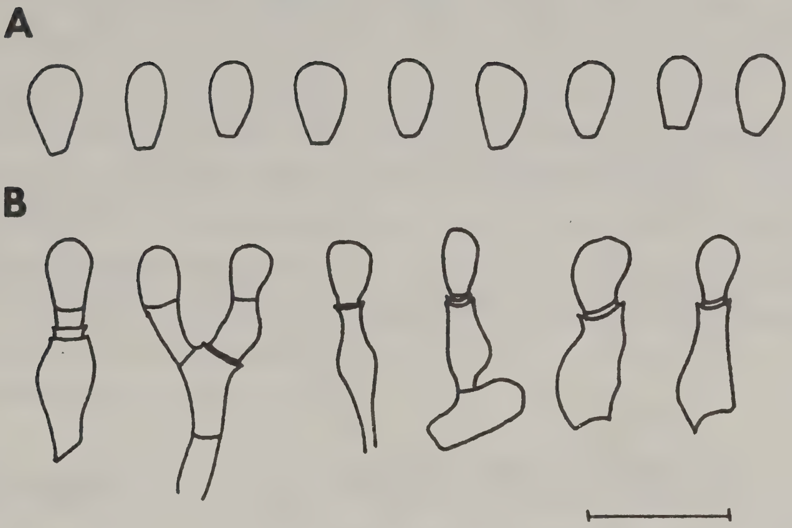

Figure 3. *Laeviomyces lecanoricola* (*Cole 4053*, MIN- holotype). A, Conidia B, Conidiophores. Scale = 10 µm.

Similis *Laeviomycei opegraphae* sed differt in conidiis latis ellipsoideis et angustioribus 4-4.5 x 2-2.5(-3) µm.

Holotypus: USA: Minnesota: Cook Co., Boundary Waters Canoe Area Wilderness, Winchell Lake, north side of the lake near arm of water heading towards Omega Lake 47 °59'36" N, 90°35'24" W, on *Lecanora wisconsinensis* apothecia on fallen *Abies balsamifera*, 7 August 1996, *Cole 4053* (MIN).

Conidiomata pycnidia, arising singly, immersed to one-third erumpent from the hymenium of the host, dark brown to black, ostiolate, (25-)50-62(-75) µm; conidial wall composed of 3-5 layers of irregularly interwoven and compacted hyphae (*textura intricata*), 8-11 µm thick, pale brown to subhyaline to hyaline and becoming intermixed with the host tissue, hyphal cells 1.5-3 µm wide. *Conidiophores* present or absent, when present angular to elongated, simple or branched at the base, pale brown. *Conidiogenous* cells holoblastic, subcylindrical to somewhat ampulliform or skittle-like, proliferating with up to 4 annellations, pale brown to brown, smooth-walled, 5-6.5(-7) x (1.5-)2-2.5(-3.5) µm. *Conidia* broadly ellipsoid, narrowed and abruptly tuncated at the base, pale brown, simple, smooth-walled, length : breadth ratio 1.6-2, 4-4.5 x 2-2.5(-3) µm.

Observations: this new species resembles *Laeviomyces opegraphae* D. Hawksw. 1981, known on thalli of corticolous *Opegrapha* species in Europe, in the small pycnidia, but differs from that species in the width and shape of the conidia. In *O. opegraphae* the conidia are 1.5-2 µm broad and have a length : breadth ratio of (2-)2.3-3. The only other two species known in the genus are *L. fallaciosus* Hafellner & Kalb 1990 known from apothecia of *Buellia multispora* in Hawaii with much longer conidia (6-8 x 3-4 µm), and *L. pertusariicola* (Nyl.) D. Hawksw. 1975 on *Buellia* and *Pertusaria* species in Europe and Canada with much larger pycnidia (100-250(-325) µm diameter) and conidia 3.5-6 x 2.5-3.5 µm. *Lawalreea lecanorae* Diederich 1990, described from apothecia of *Lecanora persimilis* in Luxembourg, has broadly falcate hyaline conidia measuring (5-)5.5-6.5(-7) x 2-3 µm.

The species of *Laeviomyces* can be distinguished by the following key:

1 Pycnidia less than 100 µm diameter 2
Pycnidia 100-250(-325) µm diameter .... **pertusariicola**

2(1) Conidia not exceeding 4.5 µm in length 3
Conidia 6-8 x 3-4 µm .... **fallaciosus**

3(2) Conidia 3-4.5 x 1.5-2 µm wide, length:beadth ratio (2-)2.3-3 . . **opegraphae**
Conidia 4-4.5 x 2-2.5(-3) µm, length:breadth ratio 1.6-2 ..... **lecanoricola**

Libertiella curvispora D. Hawksw. & Miądlikowska 1997
On *Peltigera praetextata,* Lake Co. MN C, *Cole 7316.*
New to North America.

Lichenoconium erodens M.S. Christ. & D. Hawksw. 1977
On *Cladonia caespiticia*, Lake Co. MN D, *Wetmore 82645;* on *Flavoparmelia baltimoriensis*, Reynolds Co. MO, *Cole 7500*; on *F. caperata*, Carter Co. MO, *Cole 7395, Cole 7396*; on *Flavopunctelia soredica*, Carlton Co. MN A, *Cole 1897, 1901;* Mille Lacs Co. MN, *Cole 6106;* on *F. flaventior*, Lake Co. MN A, *Cole 7288; Hypogymnia physodes*, Quebec Station 1.1, *Cole 7016;* on *Xanthoparmelia plittii,* Lake Co. MN, *Cole 7288 dupl.*

Lichenoconium lecanorae (Jaap) D. Hawksw. 1979
On *Lecanora subfusca* group, Park Co. WY B, *Wetmore 81924*; on *Melanelia septentrionalis*, Hubbard Co. MN, *Cole 4019*, on *Parmelia sulcata*, Cook Co. MN D, *Cole 4041.*

Lichenoconium usneae (Anzi) D. Hawksw. 1977

On *Flavopunctelia flaventior*, Clearwater Co. MN B, *Cole 3095*; on *F. soredica*, Carlton Co. MN B, *Cole 1974*.

Lichenodiplis lecanorae (Vouaux) Dyko & D. Hawksw. 1979

On *Caloplaca holocarpa*, St. Louis Co. MN B, *Wetmore 80001*; on *Candelaria fibrosa*, Clay Co. MN, *Wetmore 36002 B*; Mahnomen County, *Wetmore 35616 B.*

Lichenopeltella peltigericola (D. Hawksw.) R. Sant. 1993

On *Peltigera polydactyla*, Cook Co. MN G, *Cole 1887 dupl.*; on *Peltigera praetextata*, Mille Lacs Co. MN, *Schmitt 255.*

Lichenosticta alcicornaria (Linds.) D. Hawksw. 1980

On *Cladonia caespiticia*, Lake Co. MN D *Wetmore 82645.*

Marchandiomyces corallinus (Roberge) Diederich & D. Hawksw.1990

On *Evernia mesomorpha*, Cook Co. MN B, *Cole 1865,* Lake Co. MN B, *Cole 7611*; on *Flavoparmelia caperata*, Clearwater Co. MN B, *Cole 3060*; Cook Co. MN C, *Cole 1579*; Lake Co. MN B, *Cole 7619*; on *Mylechroa galbina,* Carter Co. MO, *Cole 7392*; on *Parmelia sulcata*, Lake Co. MN B *Cole 7603,* Clearwater Co. MN C, *Dzurenko 8*; on *Physcia* sp., Quebec Station 1.1, *Cole 7053*; on *Punctelia bolliana*, Ozark Co. MO, *Cole 7433*; on *Ramalina americana*, Clearwater Co. MN B, *Cole 3075*; on *Usnea hirta* Lake Co. MN B, *Cole 7609, 7610;* on *Xanthoparmelia tasmanica*, Carter Co. MO, *Cole 7585.*

Muellerella hospitans Stizenb. 1863

On *Biatora vernalis*, St. Louis Co. MN D, *Wetmore* 82321.

New to North America.

Observations: This species has previously been considered as restricted to the apothecia of *Bacidia rubella* in Europe. It has pale brown non-septate ascospores 2.5-3.5 x 2(-2.5) μm borne in multispored asci. The Minnnesota collection has ascospores which are slightly longer and narrower, (3-)3.5-4(-5) x 1.5-2(-2.5) μm, but it agrees in other respects with the species. The only other accepted lichenicolous species in the genus with simple ascospores, *M. polyspora* Hepp ex Müll. Arg. 1862 occurs mainly on *Arthonia radiata* in Europe; its ascospores are longer and broader, measuring 5-6 x 2.5-3 μm.

Muellerella pygmaea (Körb.) D. Hawksw. 1979
On *Caloplaca trachyphylina*, Sioux Co., NE, *Wetmore 77931.*

Nectriopsis cladoniicola M. S. Cole & D. Hawksw., **sp. nov.**
Etym.: *Cladoni*(*-a*)-icola (dwelling).
Figure 4

Perithecia superficialia, subglobosa, pallide rosea, 175-200 µm diameter; ascosporae 1-transseptatae, laeves, 6.5-8.5(-9.5) x 3.5-4.5(-5) µm.

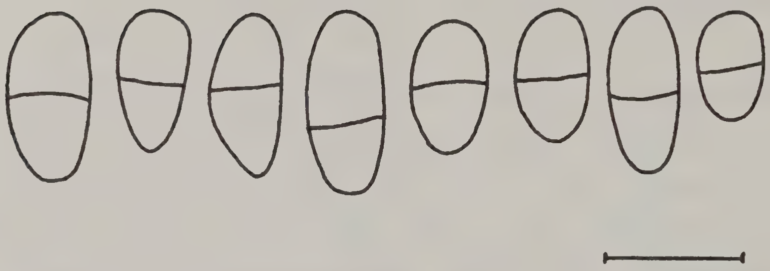

Figure 4. *Nectriopsis cladoniicola* (*Gooch 4207151-3*, MIN-holotype). Ascospores Scale = 10 µm.

Holotypus: USA: Massachusetts: Middlesex Co., Lynnfield, 42°33'45"N, 71°3'45"W., on *Cladonia* sp. basal squamules, 30 July 1998, collected by *K. Gooch*; *Cole 7733* (WIS).

Perithecia superficial, arising singly or occasionally juxtaposed on a thin subiculum, globose or subglobose, minutely papillate, not collapsing around the ostiole when dry, pale pink but more intensely pigmented and dark pink around the ostiole, covered with a loose open weft of hyphae, 175-200 µm diameter; exciple (peridium) composed of 2-3 layers of irregularly shaped polyhedral pseudoparenchymatous cells (*textura angularis*), not changing colour in potassium hydroxide, cells hyaline to very pale orange under the microscope, thin-walled, (6.5-)8-15(-22) µm diameter; peridial hyphae hyaline, flexuose, mainly 3-3.5 µm wide. *Hamathecium* absent. *Asci* broadly cylindrical to elongate clavate, short-stalked, unitunicate in structure, without any distinct apical thickening, not reacting with Lugol's iodine, 41-47 x 7-9 µm, 8-spored. *Ascospores* almost uniseriate, broadly ellipsoid, hyaline, 1-transseptate, not constricted at the septum, smooth-walled, 6.5-8.5(-9.5) x 3.5-4.5(-5) µm.

Host: *Cladonia* sp. basal squamules. The fungus occurs on decolourised parts of the thallus which are extremely friable; it therefore appears to be a pathogen.

Observations: This distinctive new species is most similar to *Nectriopsis lecanodes* (Ces.) Diederich & Schroers 1999, which occurs primarily on several genera of *Peltigerales,* with respect to the shape of the ascospores. However, that species has perithecia of 200-300 µm and ascospores which are distinctly warted and (7.5-)9-12 x 3-5.5(-7) µm. Although no nectriaceous fungus appears to have previously been reported as occurring on *Cladonia,* we note that a member of a genus that is a known anamorph of such fungi has, *viz. Acremonium rhabdosporum* W. Gams 1971 described from Austria. That *Acremonium* has been considered to be the anamorph of *N. rubifaciens* by Lowen (1995) but that species is only known on parmelioid lichens. The holotype supported very few perithecia, precluding cultural work, but if rediscovered it would be interesting to isolate single ascospores to see if they produced a similar *Acremonium.*

Nectriopsis parmeliae (Berk. & M. A. Curtis) M. S. Cole & D. Hawksw., **comb. nov.**

Basionym: *Diplodina parmeliae* Berk. & M. A. Curtis, *in* Berkeley, *Grevillea* **3**: 3 (1874).

On *Cladonia chlorophaea* group, Carter Co. MO, Peck R., *Cole 7404*, on *Parmelia sulcata*, Cook Co. MN A, *Cole 7334*; on *Physcia millegrana*, Atlantic Co., NJ, *Cole 7731* (WIS); on *Physcia stellaris*, Franklin Co., MA, *Cole 7732* (WIS).

Observations: Following the revision of generic concepts in hypocrealean fungi by Rossman *et al.* (1999), this species requires transfer into *Nectriopsis* and the necessary new combination is therefore made here. *Nectria s. str*. belongs in the family *Nectriaceae* which is characterized by generally red to purple ascomata which react with potassium hydroxide and lactic acid; the genus has a *Tubercularia* or other synemmatal or pycnidial anamorph. *Nectriopsis* is now referred to the family *Bionectriaceae* which has white to pale yellow, orange, or brown ascomata which do not react with either of the aforementioned reagents; anamorphs in the family, where known, usually belong to *Acremonium*. The primarily lichenicolous genera *Paranectria, Pronectria* and *Trichonectria* all belong to the *Bionectriaceae,* but *Xenonectriella* is placed in *Nectriaceae.*

Nectriopsis rubifaciens (Ellis & Everh.) M. S. Cole & D. Hawksw., **comb. nov.**

Basionym: *Nectria rubifaciens* Ellis & Everh., *Journal of Mycology* **3**: 116 (1887).

On *Parmelia sulcata*, Lake Co. MN B, *Cole 7607.*

Observations: Diederich & Schroers (*in* Sérusiaux *et al.* 1999) transferred this species to the genus *Trichonectria*, principally on the basis of the occurrence of thick-walled setae around the ostiole. We did not see any setae as thick-walled as those in *T. hirta* (Bloxam) Petch 1937 in the collections we studied. Further, the ascospores in *T. hirta* are vermiform and multiseptate, and the anamorph has multiseptate conidia (Butin 1983) rather than the *Acremonium* anamorph cultured from *N. rubifaciens* ascospores (Lowen 1995).

Opegrapha physciaria (Nyl.) D. Hawksw. & Coppins 1992

On *Caloplaca rosei*, Santa Barbara County, *Bratt 5141.*

New to North America.

Opegrapha wetmorei M. S. Cole & D. Hawksw., **sp. nov.**

Etym.: In honour of Clifford M. Wetmore in recognition of his meticulous contributions to lichenology and the help he has given the first author over many years.

Figure 5.

Apothecia breve lirelliformia, 0.3-0.4 x 0.2-0.3 µm vel 0.2-0.3 mm diameter; ascosporae (2-)3 septatae, pallide brunneae, verruculosae, 14.5-17.5 x (4.5-) 5-6(-6.5) µm.

Holotypus: USA: Minnesota: Lake Co., Superior National Forest, E of Pine Lake, N of Toimi, 19 miles SE of Hoyt Lakes, 47°27'51"N, 91 °45'26"W, on *Ochrolechia trochophora* on *Thuja*, 21 June 1999, *C. M. Wetmore 82244* (MIN).

Apothecia superficial, mostly arising singly but sometimes aggregated into small groups, shortly lirelliform to rounded, with a single slit exposing the hymenium or with several slits extending to the margin, black, shiny, with convex raised margins, mainly 0.3-0.4 x 0.2-0.3 µm or 0.2-0.3 mm diameter, sometimes coalescing to form composites of up to about 0.6 mm across; epithecium pale brown, 12.5-18 µm tall; hymenium colourless, 63-88 µm tall; hypothecium made up of excipular tissues. *Exciple* raised, carbonaceous, very variable in thickness, 16-25-45(-72) µm thick, extending

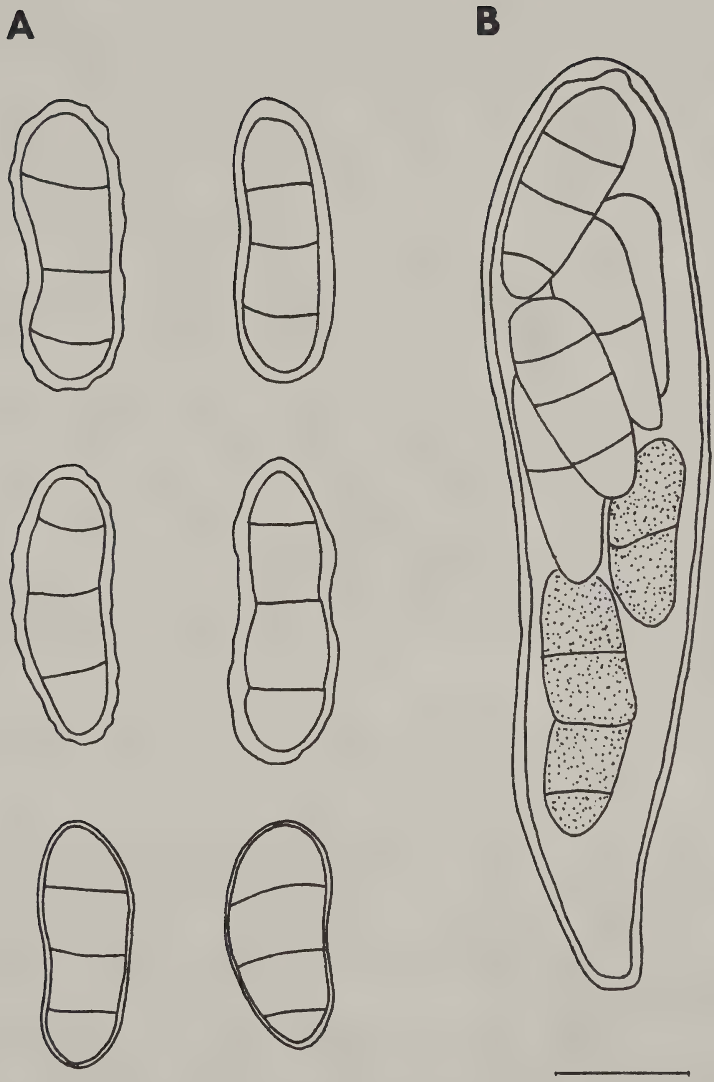

Figure 5. *Opegrapha wetmorei* (*Wetmore 82244*, MIN- holotype). A, Ascospores B, Ascus Scale = 10 µm.

below the hymenium, mainly amorphous in structure, composed of thick-walled red-brown to dark brown to black pseudoparenchymatous angular to rounded compacted cells (*textura angularis*), colour unchanged in potassium hydroxide, cells mainly 6-8 µm diameter. *Hamathecium* of branched and anastomosing paraphysoids, mainly 1-1.5 µm thick, the tips nodulose, not pigmented, 1.5-2 µm wide. *Asci* elongate clavate, short-stalked, bitunicate in structure, apex thickened with an internal apical beak, discharge not seen, 28-35(-38) x 4.5-6.5 µm, 8-spored. *Ascospores* distichously arranged in the ascus, elongate-ellipsoid to broadly fusiform, subhyaline at first in the ascus but soon becoming pale brown, (2-)3-septate, somewhat constricted at the septa, walls unevenly thickened and coarsely ornamented with refractive warts *c.* 0.5 µm across, 14.5-17.5 x (4.5-)5-6(-6.5) µm.

Host: On the thallus, and more rarely the thalline exciple, of *Ochrolechia trachophora.* The fungus does not appear to adversely affect the host, the thallus retaining its normal colour, so the species appears to be a commensal.

Observations: The lichenicolous species of *Opegrapha* appear to be mainly restricted to particular host genera or species. None has previously been recognized as occurring on *Ochrolechia*, although one has been described from *Pertusaria, O. pertusariicola* Coppins & P. James 1979, which has 4-spored asci and (5-)6-septate narrower ascospores (21-28 x 4.5-6 µm). In the key published by Hafellner (1994) the species comes closest to *O. thelotrematis* Coppins 1987, known only from *Thelotrema* species; that species also has small and often aggregated apothecia, but the ascospores remain hyaline for longer and the exciple turns greenish in potassium hydroxide.

Paranectria oropensis subsp. **parviseptata** M. S. Cole & D. Hawksw., **subsp. nov.**

Etym.: parvi-(sparsely) septata (septate).

Figure 6

Similis *Paranectriis oropensis* subsp. *oropensis* sed differt in ascosporiis pancioribus septatis, (2-)3-4(-5) transseptatis et (0-)1(-2) longiseptatis, nonnil brevioribus (21.5-)23-27(-29) x (10-)11-14 µm.

Holotypus: Taiwan: Hualien Hsien, Kuanynan, on *Parmelia* (*Hypotrachyna*) sp. on *Pinus,* alt. 2370 m, 3 May 1996, *D. L. Hawksworth* (K(M) 69600).

Perithecia superficial, arising singly on a thin subiculum, subglobose, indistinctly to minutely papillate when fresh, becoming depressed around the ostiole when dry, pale orange throughout, covered with

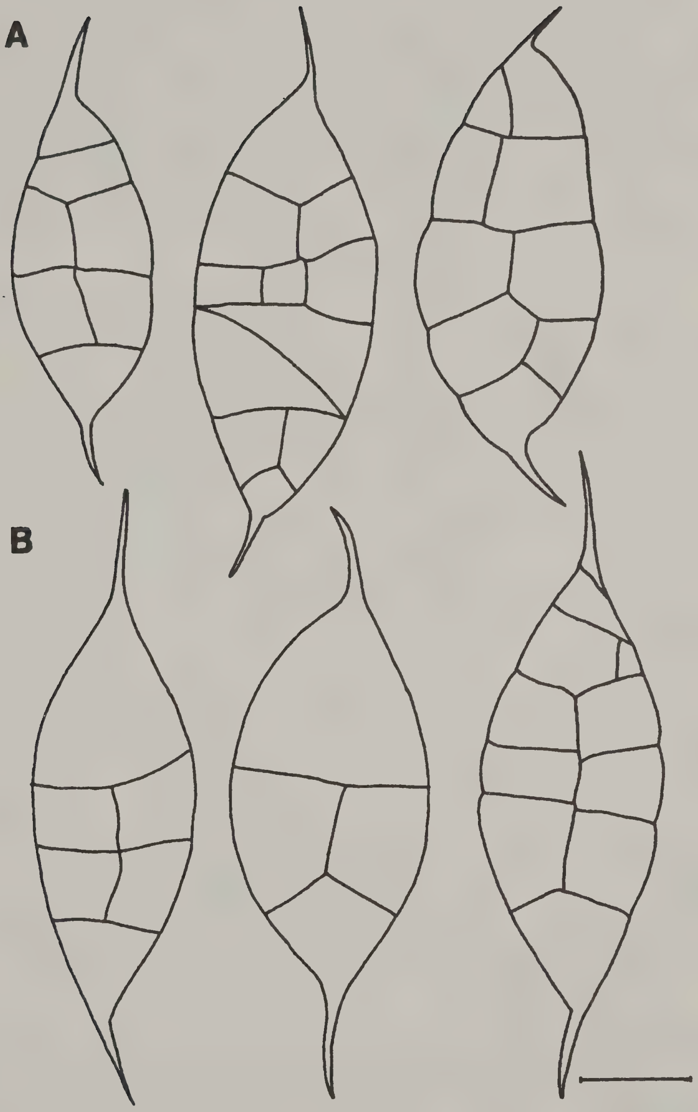

Figure 6. *Paranectria oropensis* subsp. *parviseptata* A, Ascospores from Taiwan specimen (*Hawksworth*, K(M) 69600- holotype). B, Ascospores from Minnesota specimen (*Wetmore 82511*, MIN). Scale = 10 µm.

a weft of hyphae, 1.5-2(-2.5) mm diameter; exciple (peridium) composed of 2-3 layers of polyhedral pseudoparenchymatous cells (*textura angularis*), not changing colour in potassium hydroxide, cells hyaline to very pale orange, thin-walled, (8-)10-18(-22) µm diameter; peridial hyphae hyaline, flexuose, mainly 2.5-3.5 µm wide. *Hamathecium* absent. *Asci* broadly cylindrical to elongate-clavate, long-stalked, unitunicate in structure, without any distinct apical thickening, not reacting with Lugol's iodine, 90-125 x 11-15 µm, 8-spored. *Ascospores* overlapping uniseriate, broadly fusiform with robust arcuate apical and basal appendages (1.5-)5-8(-10) µm long, muriform, with (2-)3-4(-5) transsepta and (0-)1(-2) longisepta in each cell, the septa often oblique, guttulae often evident, hyaline, smooth-walled, (21.5-)23-27(-29) x (10-)11-14 µm (excluding apical appendages).

Host: *Parmelia* (*Hypotrachyna*) sp., *Bacidia schweinitzii*, and *Lepraria incana*. In all cases it occurs on decolourised areas of the thallus suggesting it is pathogenic.

Observations: This taxon was first recognized in material collected in Taiwan, differing from previous collections of *P. oropensis* (Ces.) D. Hawksw. & Piroz. 1977 in the somewhat shorter spores with consistently fewer septa and cells. The discovery of a specimen with similar ascospore characters in Minnesota, and the large numbers of ascospores seen in that material, convinced us that this difference is a character of the taxon and not due to immaturity. The two collections differed only in the lengths of the ascospore appendages, which were (1.5-)2.5-4(-5.5) µm in the one from Minnesota, and 7-10 µm in the one from Taiwan. A third collection from the UK with ascospores of a similar size and septation to the MN and Taiwan specimens came to our attention while this paper was in preparation. In subsp. *oropensis,* which is known from a wide range of foliose and squamulose lichens, the ascospores are (22-)25-32(-36) x (9-)11-14(-15) µm (Hawksworth 1982) and have (5-)6-7(-9) transsepta with (0-)1-2(-3) longisepta in each cell. The length: breadth ratio of the spore bodies is identical in both subspecies, ranging from 1.8-2.5. Samuels (1976) gave the ascospores as 28-36 x 9-11 µm, based on a single collection, and this was copied in Rossman *et al.* (1999). We treat this as a subspecies as the ascospore characters overlap to some extent; it will be interesting to see whether the difference holds up as more specimens are discovered.

Additional specimens: USA: Minnesota: St Louis Co., Superior National Forest, SE of Marion Lake on USFS 203, 8 miles W of Crane Lake, 48°16'27" N, 92°38'24"W, on *Bacidia schweinitzii* on *Thuja*, 29 June 1999, *C. M. Wetmore 82511* (MIN), United Kingdom: Suffolk, Baylham, 62/102515, *Lepraria incana* on *Acer campestris*, 9 June 2000, *C.J.B. Hitch & P.M.H Earland-Bennett* (K(M)).

Patriciomyces valentinianus D. Hawksw., **gen. sp. nov.**

Etym.: In honour of Patricia A. Taylor-Hawksworth who facilitated the study of the lichenicolous fungi discussed in this contribution and named as a St Valentine's day gift on 14 February 2000.

Figure 7

Conidiomata superficialia, sporodochia, compacta, pallide aurantiaca, (0.3)-0.4-0.6(-0.8) mm lata et 0.2-0.4 mm alta. Conidiophora macronematata, hyalina, ramosa, (3.5-)4-5.5(-6) µm crassa. Cellulae conidiogenae terminales vel laterales, apparenter holoblasticae, subulatae, 30-55 µm altae, basi 3-4(-4.5) µm crassis et apice 1-1.5 µm latis. Conidia hyalina, 1-septata, biconica, (17.5-)18-20(-22.5) µm.

Holotypus: USA: Missouri: Carter Co., Peck Ranch Conservation Area, vicinity of Stegall Mountain fire tower, 37°4-5'30"N, 91°12'W, alt. 1200-1340 ft, on thallus of *Physcia stellaris* on dead hickory, 12 October 1997, *M. S. Cole 7394* (MIN).

Colonies superficial, sporodochial, irregular in shape, plano-convex, compact, gelatinized, pale orange, somewhat translucent when moist, arising on a white subiculum evident at the basal margins, (0.3-)0.4-0.6(-0.8) mm across, 0.2-0.4 mm tall. *Subiculum* arachnoid, discontinuous, often as tooth-like projections, hyphae hyaline, irregularly branched, repeatedly septate, not constricted at the septa, (3.5-)4-5 µm thick, walls smooth to minutely granular and often with small refractive wart-like protruberances 0-5-1.5 µm. *Conidiophores* macronematous, arising vertically from more or less horizontal subicular hyphae, erect, compacted into a hymenium-like layer 80-110 µm tall, hyaline, smooth-walled above but occasionally with sparse wart-like protruberances like those on the subicular hyphae, repeatedly sympodially branched, with 1-3 conidiogenous cells arising at each node, septate, (3.5-)4-5.5(-6) µm thick. *Conidiogenous cells* arising terminally and laterally on the conidiophores, colourless, smooth-walled, terminating at about the same level, 30-55 µm tall, colourless, smooth-walled, awl-shaped, constricted at the base, somewhat swollen, geniculate and 3-4(-4.5) µm below, gradually tapering to a pointed tip 1-1.5 µm wide, lacking any evident periclinal thickening, conidiogenesis apparently holoblastic. *Conidia* arising in chains, easily disarticulating, narrowly biconical, both apices attenuated and truncated by scars of former attachment, 1-septate, not constricted at the septum, the septum slightly thickened and refractive, hyaline, smooth-walled, without any sheath, (17.5-)18-20(-22.5) µm.

Host: *Physcia stellaris,* on older parts of the thallus which are somewhat bleached and friable. It is unclear whether the fungus is an opportunist saprobe or the pathogen responsible for the symptoms.

Observations: The only lichenicolous fungus known which produces similar pale orange translucent sporodochia of compacted conidiogenous

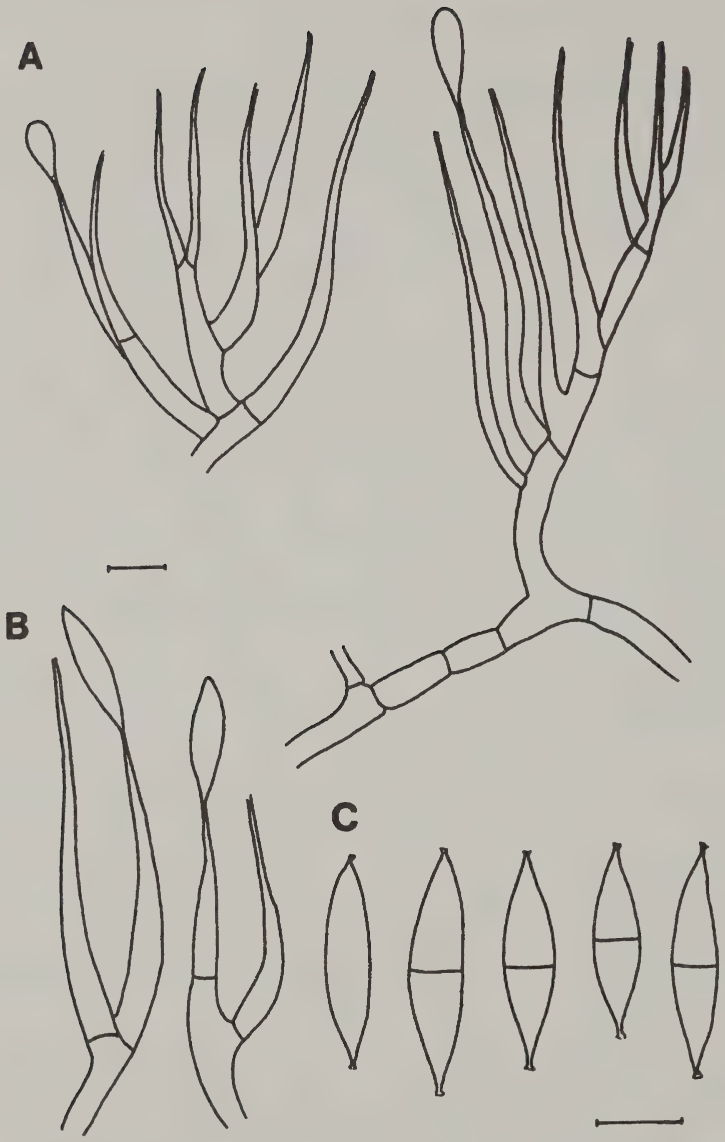

Figure 7. *Patriciomyces valentinianus* (*Cole 7394*, MIN- holotype). A, Branching pattern of conidiophores. B, Conidiophores. C, Conidia. Scale = 10 μm.

cells is *Dendrodochium subeffusum,* known only from the original collection on *Physcia millegrana* (and adjacent thalli of *Candelaria concolor*) in New York (Hawksworth 1979a). However, that fungus produces non-septate solitary conidia truncated at the base and rounded at the apex. The new fungus shows some superficial similarities with *Septofusidium* (Gams 1971; Samson 1974) but in that genus the conidia are produced enteroblastically on conidiogenous cells with periclinal apical thickenings and are generally simple (in some cases occasionally 1-septate in culture) and ellipsoid and not biconic; further both ends of the conidia have minute protuberances suggesting the conidial secessation is rhexolytic. *Patriciomyces* clearly warrants an electron microscopic study to elucidate the details of conidiogenesis. The genera also differ in their biology as *Septofusidium* species are probably anamorphs of *Hypocreales,* and are mainly known as isolates from vascular plant tissues, soil or air, and none are recorded as fungicolous or lichenicolous. We note that our new fungus shows some similarity to *S. variabile* (Matsush.) Samuels 1989 (Matsushima 1975; Samuels 1989), in that the conidia are apiculate, but in that fungus the conidia are 1-8- septate, elongate-fusiform and not biconic, and the conidiogenous cells have the periclinal thickenings typical of *Septofusidium.*

Phacopsis oxyspora (Tul.) Triebel & Rambold 1988
On *Xanthoparmelia plittii*, Lake Co. MN. A. *Cole 7288.*

Phaeosporobolus usneae D. Hawksw. & Hafellner 1986
On *Evernia mesomorpha*, Station 2.4 Quebec, *Cole 7149*; on *Flavoparmelia caperata*, Buncombe Co. NC; on *Punctelia semansiana*, Douglas Co. MO, *Cole 7561*; on *Usnea fulvoreagens*, Cook Co. MN E, Cole 4061 dupl.; on *Usnea subfloridana*, Cook Co. MN B, *Cole 1865*.

Phoma cytospora (Vouaux) D. Hawksw. 1976
On *Flavoparmelia baltimorensis*, Carter Co. MO, *Cole 7587*, on *Parmelia sulcata*, Carlton Co. MN A, *Cole 1906 C*, Clearwater Co. MN A, *Cole 1750*; on *Parmelia squarrosa*, Carlton Co. MN A, *Cole 1906.*
New to North America.

Pronectria erythrinella (Nyl.) Lowen 1990
On *Peltigera didactyla*, Teton Co., WY, *Wetmore 81971.*

Pyrenidium actinellum Nyl.
On *Physcia caesia,* Cook Co., MN A, *Cole 7266.*

Sclerococcum simplex D. Hawksw. 1979

On *Pertusaria ophthalmiza*, St. Louis Co. MN A, *Wetmore 34765B, Wetmore 39375*, *Wetmore 40239B.*

New to North America.

Observations: This species has not been reported since its original description on the same host collected in Scotland. The species grows with *Taeniolella laevistipitata* in *Wetmore 40239B.*

Scutula epiblastematica (Wallr.) Rehm 1889

On *Peltigera polydactyla*, Lake Co. MN D, *Wetmore 82660,* Mercer Co. ND, *Wetmore 82354.*

Scutula miliaris (Wallr.) Trevis. 1853

On *Peltigera polydactyla,* Oregon Co. MO, McCormack Lake, *Cole 7493, Cole 7474* (as anamorph *Karsteniomyces peltigerae).*

Scutula stereocaulorum (Anzi) Körb. 1865

On *Stereocaulon tomentosum,* Quebec Station 2.5, *Cole 7169.*

Stigmidium cerinae Cl. Roux & Triebel 1994

On *Caloplaca luteominia*, Ventura Co. CA, *Bratt 8139,* Ventura Co CA A, *Bratt 7873*; on *Caloplaca rosii*, Santa Barbara Island, *Bratt 5141*; Baja California Norte, *Wetmore 75720*, on *Caloplaca tracyphyllina*, Sioux Co. NE, *Wetmore 77785.*

New to North America.

Observations: The ascospores of this species vary somewhat in shape. Most of the collections we studied had ellipsoid ascospores (9-)10-12.5(-13) x 3-4 µm, conforming to the original description. However, the NE specimen had more broadly ellipsoid ascospores recalling those figured by Hafellner (1994). The *Stigmidium* species on *Caloplaca* may merit a more critical global study.

Stigmidium fuscatae (Arnold) R. Sant. 1986

On *Acarospora fuscata*, St. Louis Co. MN A, *Wetmore 34525.*

Stigmidium pumilum (Lett.) Matzer & Hafellner 1990

On *Physcia caesia*, Cook County MN A, *M.S. Cole 7266.*

Figure 8

New to North America.

Ascomata black, perithecioid, superficial, 25-45 (-75) µm diameter,

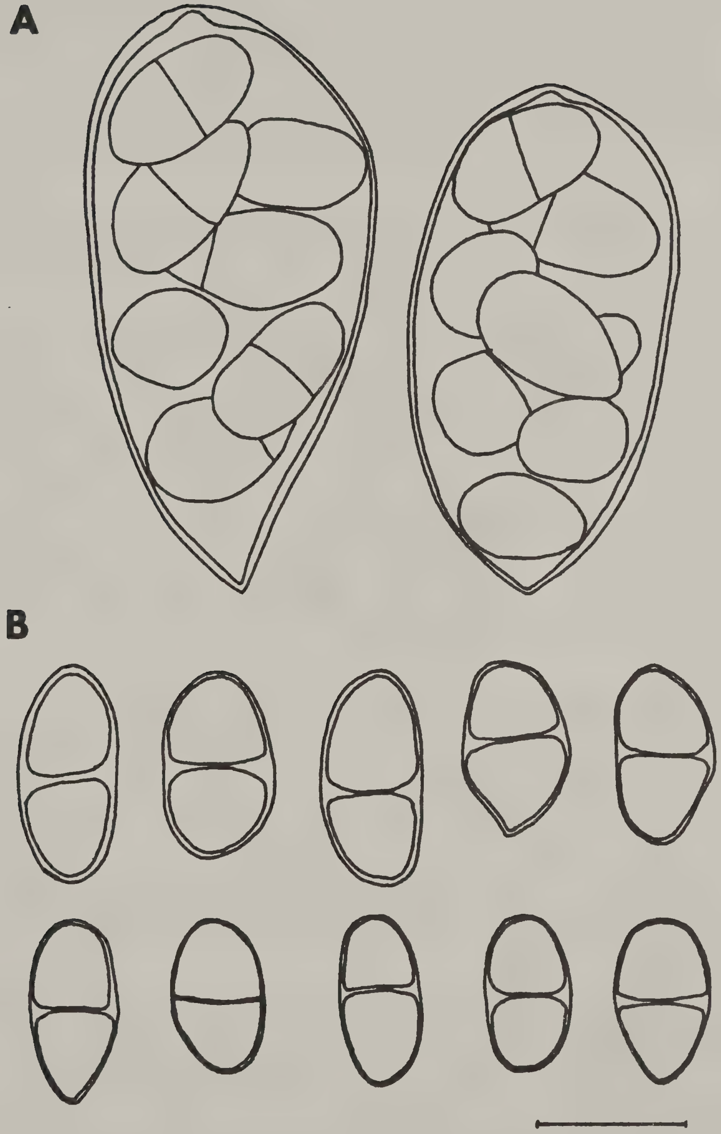

Figure 8. *Stigmidium pumilum* (*Cole 7266*, MIN). A, Ascus. B, Ascospores. Scale = 10 µm.

creating a gall on the host where perithecia are numerous. *Mycelium* superficial, hyphae dark brown, smooth, 5.5-7 µm wide, branching off a central strand, extending over the thallus but not in a network. *Ascomatal wall* composed of red-brown irregularly polyhedral ascomata cells, with cells 5-10 µm diameter. Hamathecium tissues not seen. *Asci* broadly clavate, wall apically thickened with a distinct ocular chamber, circa 28-32 x 15 µm, 8 spored, with ascospores irregularly arranged in the ascus. *Ascospores* 1-septate, oval, hyaline when young, light brown at maturity, 9-13 x 5.5-6.5 µm.

Host: *Physcia caesia*. Groups of well developed perithecia are associated with the formation of bullate galls on the host thallus. The host appears somewhat darker than normal due to the superficial hyphae, but damage to the host other than the galls is not apparent.

Observations: This fungus is unusual for *Stigmidium* in that it has a well-developed superficial mycelium recalling that of *Sphaerellothecium* but differing in that this does not take the form of a network, and further the hyphae are smooth-walled. In addition, the absence of paraphysoids indicates that *Stigmidium* is a more appropriate placement for the species than *Sphaerellothecium* (Roux & Triebel 1994). The species appears to be confined to *Physcia caesia* and *P. dubia* but widespread and is reported from Europe, the Canary Islands, and New Zealand by Matzer & Hafellner (1990), and from Chile by Wedin (1994). We have included a description to facilitate its future recognition in North America, as it does not appear to have been described in English before.

Taeniolella caespitosa M. S. Cole & D. Hawksw., **sp. nov.**

Etym.: From Latin 'caespitosus', growing in tufts, recalling the habit.

Figure 9

Conidiophora superficialia, leve, rubro-brunnea, 50-85 x (4-)6-7.5 µm. Conidia catenata, atrobrunnea, laevigata, late ellipsoidea vel doliformia, (0-)1-2 septata, 8-14 x 4.5-7.5 µm.

Holotypus: Canada: Quebec: Quebec Co., Stoneham, Mont Wright Parc de Conservation Municipale, 47°00'42" N, 71°20'45" W, alt. 230 m, on *Pertusaria* sp. on *Acer saccharum,* 7 August 1997, *M. S. Cole & I. M. Brodo 7038* (MIN).

Colonies discrete, scattered, black, somewhat shiny, irregular in shape, 25-60(-75) µm diameter, sometimes confluent; mycelium immersed in the upper layers of the cortex to almost superficial, confined to the basal areas of the conidiophores, composed of pale grey-brown flexuose hyphae, sometimes with uneven wrinkled walls, variable in thickness, mainly 4-7µm thick. *Conidiophores* semi-macronematous, arising in discrete tufts, erect,

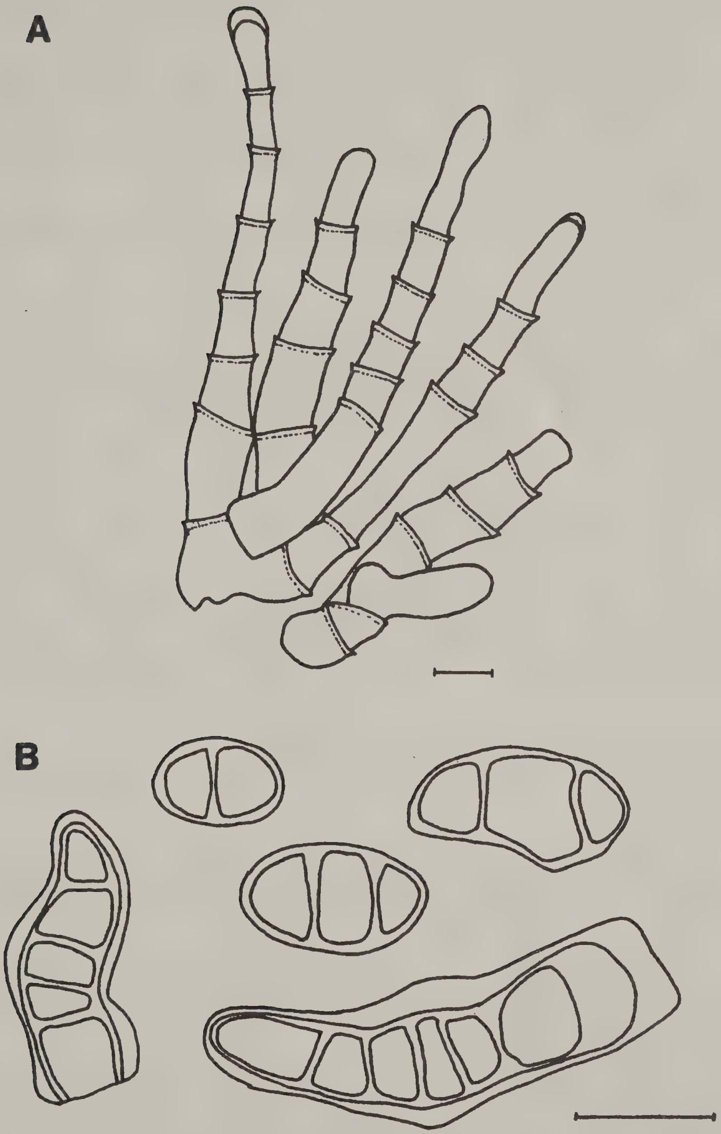

Figure 9. *Taeniolella caespitosa* (*MS Cole & IM Brodo 7038*, MIN-holotype). A, Conidiophores. B, Conidia. Scale = 10 µm.

simple or branched at the base, dark red-brown below, becoming paler brown towards the apices, smooth-walled, repeatedly septate, not or slightly constricted at the septa, individual cells 8.5-10(-11) µm in length, overall 50-85 x (4-)6-7.5 µm. *Conidiogenous* cells monoblastic, integrated, terminal, short-cylindrical, not or scarcely distinguishable from the coniodiophores, occasionally proliferating and leaving inverted skirt-like wall remnants. *Conidia* adhering for a long time to the conidiogenous cells, separating with difficulty,dark brown, broadly ellipsoid to doliform, smooth-walled, (0-)1-2 septate units breaking away, 8-14 x 4.5-7.5 µm.

Host: *Pertusaria* sp. The host thallus retains its normal white colour and does not appear to be harmed by the *Taeniolella* which is therefore evidently a commensal.

Observations: The lichenicolous species referred to *Taeniolella* are generally rather narrowly host-restricted and characteristically commensalistic. Eleven lichenicolous species have been described to date of which one occurs on *Pertusaria, T. pertusariicola* D. Hawksw. & H. Mayrh. 1990 known from *P. carneopallida* in Greenland and Sweden. However, *T. pertusariicola* is clearly separated from *T. caespitosa* in having coarsely ornamented warted conidiophores, conidiogenous cells and conidia, and further in the much shorter conidiophores which are 10-30 µm tall. Two further species are, however, known to us on *Pertusaria,* the one described below as *T. laevistipitata* with much thicker conidiophores, and an undescribed species from Australia also with smooth-walled conidia which are mainly 2-septate and 12-16 x 5-7 µm (Victoria, Maffra, on *P.* sp. on *Hymenanthra banksii,* March 1889, *F. R. M. Wilson,* NSW L4335 p.p.).

Taeniolella laevistipitata M. S. Cole & D. Hawksw., **sp. nov.**

Etym.: From Latin 'laevis' (smooth) and 'stipitatis' (stalked) recalling the smooth conidiophores.

Figure 10

Conidiophora superficialia, laeve, pallide rubro-brunnea, (93-)120-170(-192) x 8-11(-11.5) µm. Conidia catenata, atrobrunnea, laevigata, late ellipsoidea vel leviter arcuata, (0-)1-2(-3) septata, 17.5-24 x 7-8 µm.

Holotypus: USA: Minnesota: St Louis Co., Voyageurs National Park, N side of small bay S of Mukooda lake, Sand point Lake area, 48°19'14"N, 92°28'14"W, on *Pertusaria ophthalmiza* on *Acer rubrum*, 15 July 1997, *C. M. Wetmore 40239B* (MIN).

Colonies discrete, scattered in a few areas of the thallus, black, somewhat shiny, plano-convex to subglobose, 50-80 µm diameter; mycelium immersed in the upper layers of the cortex, confined to the basal areas of the conidiophores, composed of pale brown flexuose hyphae, mainly 5-8 µm

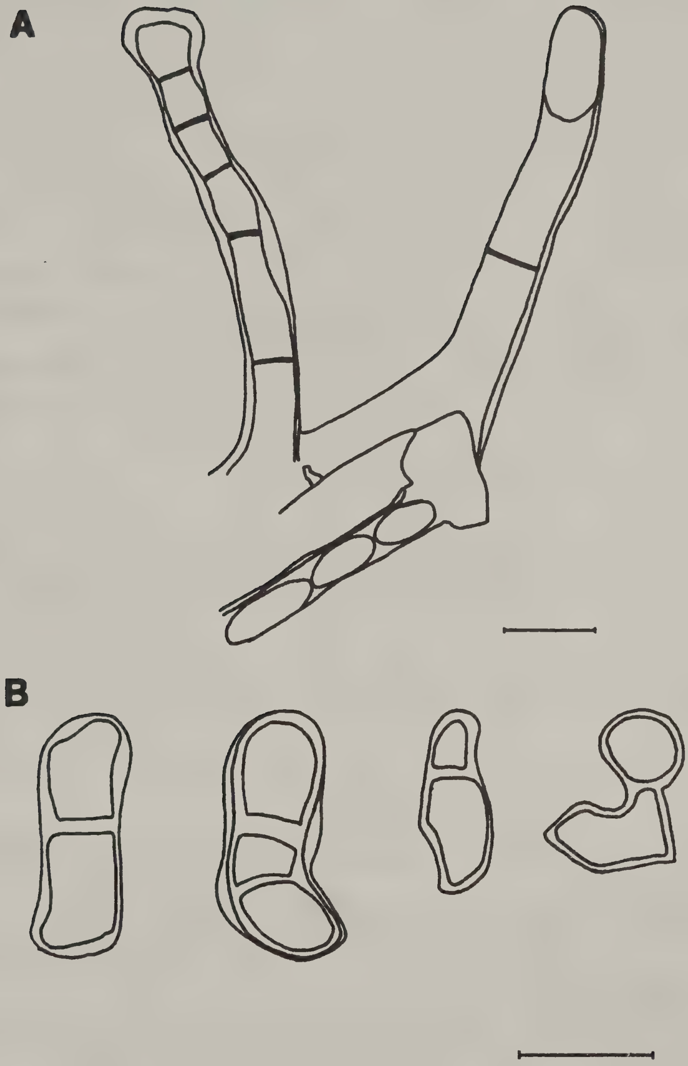

Figure 10. *Taeniolella laevistipitata* (*Wetmore 40239B*, MIN- holotype). A, Conidiophores. B, Conidia. Scale = 10 µm.

thick. *Conidiophores* semi-macronematous, arising in discrete tufts, erect to somewhat decumbent and intertwined, simple or branched at the base, pale red-brown, becoming much paler brown towards the apices, smooth-walled, repeatedly septate, not or slightly constricted at the septa, individual cells (9-)11-19(-23) µm in length, overall (93-)120-170(-192) x 8-11(-11.5) µm. *Conidiogenous cells* monoblastic, integrated, terminal, short-cylindrical to elongate-cylindrical, not or scarcely distinguishable from the coniodiophores, occasionally proliferating and leaving inverted skirt-like wall remnants. *Conidia* adhering for a long time to the conidiogenous cells, separating with difficulty, variable in shape, mainly broadly ellipsoid and truncated at one or both ends, sometimes somewhat curved, red-brown, smooth-walled, (0-)1-2(-3) septate units breaking away, 1-2 septate conidia 17.5-24 x 7-8 µm.

Host: *Pertusaria ophthalmiza* thallus and apothecial margins, growing with *Sclerococcum simplex*. The species does not cause any discolouration of the host thallus and is apparently commensalistic.

Observations: This new species is distinct from the other three species of *Taeniolella* known on other *Pertusaria* species in the much paler colour and taller conidiophores, and large and smooth conidia.

ACKNOWLEDGEMENTS

We are indebted to Clifford M. Wetmore and Charis Bratt for access to their collections with lichenicolous fungi, and to Patricia A. Taylor-Hawksworth for facilitating the preparation of this contribution. We also wish to thank the Royal Botanic Gardens Kew for access to their Library and collections. This paper was completed while D.L.H. was serving as an invited Professor at the Universidad Complutense in Madrid.

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MYCOTAXON
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NEW COMBINATION AND NEW RECORDS OF SMUT FUNGI FROM TROPICAL CHINA

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ABSTRACT *Sporisorium microstegii* (S. Ahmad) L. Guo and *Sporisorium modestum* (H. Syd.) H. Scholz are new to China. *S. microstegii* is proposed as a new combination.

摘要 本文报道 2 种中国新记录种，莠竹孢堆黑粉菌[*Sporisorium microstegii* (S. Ahmad) L. Guo]和冠芒草孢堆黑粉菌[*Sporisorium modestum* (H. Syd.) H. Scholz]。其中莠竹孢堆黑粉菌是新组合。

KEY WORDS *Sporisorium microstegii, Sporisorium modestum,* Smut fungi, New combination, New records, China

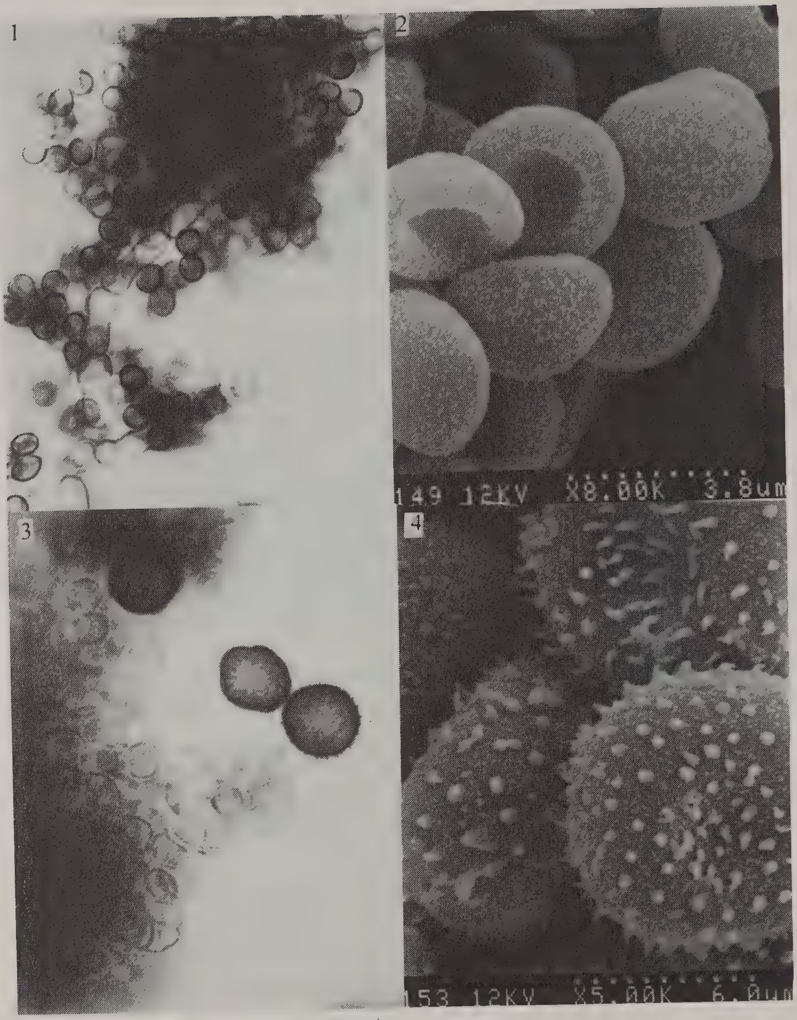
During the mycological expeditions to the tropical region of Yunnan province and Helan Mountain of Ningxia province, two smut fungi new to China have been discovered (Guo, 2000). For one of them the following new combination is proposed.

Sporisorium microstegii (S. Ahmad) L. Guo, **comb. nov**. Figs. 1-2
Basionym: *Sphacelotheca microstegii* S. Ahmad, Mycol. Papers 64:6, 1956 (as *microstegiae*).
Ustilago microstegii (S. Ahmad) Vánky, Mycotaxon 51:173, 1994.

Sori in inflorescences, cylindrical 25-45 mm long, ca. 1 mm wide, covered by a thin whitish peridium. Spore mass blackish-brown, powdery. Columella single. Ustilospores subglobose, ovoid or ellipsoidal, 4-6 x 3-4.5 μm, olivaceous-brown, smooth in LM, minutely verruculose in SEM. Chain of sterile cells up to 102 μm long. Sterile cells variable in shape and size, globose, subglobose, ovoid, cylindrical or irregular, 6-10.5 x 4.5-8.5 μm, hyaline or yellowish, smooth.

On *Microstegium delicatulum* (Hook. f.) A. Camus, Yunnan: Luchun, October 30, 1999, L. Guo 1681, HMAS 80484.

Supported by the National Natural Science Foundation of China.


1
2
149 12KV X8.00K 3.8um
3
4
153 12KV X5.00K 6.0um

Figs. 1-2. *Sporisorium microstegii* (S. Ahmad) L. Guo on *Microstegium delicatulum* (Hook. f.) A. Camus (HMAS 80484). 1) Ustilospores and sterile cells in LM (x 1100). 2) Ustilospores in SEM (x 8000).

Figs. 3-4. *Sporisorium modestum* (H. Syd.) H. Scholz on *Enneapogon borealis* (Griseb.) Honda (HMAS 80483). 3) Ustilospores and sterile cells in LM (x 1100). 4) Ustilospores in SEM (x 5000).

The Chinese material was compared with the type specimen of *Sphacelotheca microstegii* S. Ahmad collected from Pakistan, and kept in IMI. They are identical in sorus characteristics, size and shape of ustilospore and sterile cells, but the type specimen has longer sori, up to 72 mm.

The presence of sorus peridium, sterile cells and columella composed of host plant are typical for the genus *Sporisorium*. In my opinion, this species is placed better in the genus *Sporisorium* than in the genus *Ustilago*.

Sporisorium modestum (H. Syd.) H. Scholz, Figs. 3-4
in Fraiture, Bull. Jard. Bot. Nat. Belg. 66:171, 1997.
Ustilago modesta H. Syd., Ann. Mycol. 33:231, 1935.
Sphacelotheca modesta (H. Syd.) Zundel, Bothalia 33:301, 1938.

Sori in all ovaries, covered by a green peridium. Spore mass black, powdery. Ustilospores subglobose, ellipsoidal or slightly irregular, 11-15 (-16.5) x 9-12.5 µm, brown or dark brown, echinulate or verrucose; the spines and warts variable in size, up to 1 µm high, in SEM finely verruculose between the spines or warts. Sterile cells subglobose, ovoid or ellipsoidal, 5.5-10.5 x 5-7.5 µm, hyaline, smooth.

On *Enneapogon borealis* (Griseb.) Honda, Ningxia: Helan Shan, August 30, 1997, L. Guo & Kuan-cang Wang 1500, HMAS 80483.

The Chinese material was compared with the type specimen collected from South Africa, and kept in BPI. They are identical in sorus characteristics, size and shape of ustilospores and sterile cells, but the type specimen has longer warts of ustilospores.

Sporisorium modestum (H. Syd.) H. Scholz not only is new to China, but also new to Asia. Previously, this species was only reported from Africa (Sydow, 1935; Scholz *in* Fraiture, 1997).

Enneapogon borealis is a new host plant for the species *Sporisorium modestum*.

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NEW SPECIES AND NEW RECORDS OF FUNGI FROM TROPICAL CHINA: HYPHOMYCETES*

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ABSTRACT: Two new species, *Pseudocercospora mytilariae* Y. L. Guo and *Pseudocercospora schefflericola* Y. L. Guo, the first record of the genus *Tomenticola* Deighton from China and nine new Chinese records of species from tropical China are reported. Latin diagnoses and illustrations of the new species are provided. The specimens examined are deposited at HMAS.

KEY WORDS: *Pseudocercospora, P. mytilariae, P. schefflericola.*

Cercospora forsteriana Chupp & Viégas, Bol. da Soc. Brasil. de Agron. 8: 26, 1945.

Fruiting amphigenous. Stromata globose, brown to dark brown, 15.0-35.0 μm diam. Conidiophores 3-18 or more stalks, fasciculate, medium brown, 2-7-geniculate, 2-8-septate, 45.0-300.0 × 3.5-5.0 μm. Conidia acicular to obclavate, hyaline, indistinctly multiseptate, 40.0-287.5 × 2.5-4.8 μm.

On *Juglans cathayensis* Dode.: Nanjing, Jiangsu Province (HMAS 78868).

Cercospora forsteriana Chupp & Viégas was originally reported on *Juglans regia* L. from Brazil, with conidiophores [20.0-65.0(-90.0) × 3.5-5.0 μm] and conidia (25.0-120.0 × 2.0-4.0 μm) shorter than on *Juglans cathayensis* Dode in China.

Cercospora juglandis Kellerm. & Swingle on *Juglans nigra* L. differs in having shorter conidiophores (15.0-65.0 × 3.0-4.5 μm), and cylindrical, coloured (subhyaline to pale fuligenous), catenulate, shorter conidia (20.0-85.0 × 3.0-5.5 μm), and was plased by Bruan (in Braun & Melnik, 1997) in the new genus *Pseudophaeoramularia.*

Cercospora stachydis Ellis & Everh., Bull. Torrey Bot. Club. 24: 474, 1897.

Fruiting amphigenous. Stromata lacking or only a few globose brown cells. Conidiophores solitary or 2-11 fasciculate, olivaceous brown to pale brown, 1-2-geniculate, 3-9-septate, 22.5-225.0 × 4.0-5.8 μm. Conidia acicular to obclavate, hyaline, 4-multiseptate, 35-125.0 × 3.0-4.8 μm.

On *Stachys japonica* Miq.: Hangzhou, Zhejiang Province (HMAS 78891).

Cercospora strobilanthidis Chidd., Mycopathol. Mycol. Appl. 17: 77, 1962.

Fruiting hypogenous. Stromata none or small, brown. Conidiophores solitary or 2-12 fasciculate, olivaceous brown to pale brown, 1-6-geniculate, 1-7-septate, 34.5-250.0 × 4.3-5.4 μm. Conidia acicular, hyaline, indistinctly 3-multiseptate, 50.0-195.0 × 3.2-5.4 μm.

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* Supported by the National Natural Science Foundation of China (Approved No. 39730020)

On *Strobilanthes* sp.: Huidong, Guangdong Province (HMAS 79095).

Cercospora strobilanthidis Chidd., originally reported from India, was described with stromata 13.6-25.5 μm diam., conidiophores 5-15 fasciculate, 46.8-125.8 × 4.2-5.1 μm, and conidia obclavate to acicular, 34.0-137.7 × 3.0-3.4 μm. In the collection from China, the conidiohores are longer, and the conidia are slightly longer and wider those described by Chiddarwar.

Pseudocercospora mytilariae Y. L. Guo, sp. nov. Fig. 1

Maculae amphigenae, suborbiculares vel angulares, 0.5-2.0 mm latae, atro-brunneae vel griseo-brunneae. Caespituli amphigeni. Mycelium immersum. Stromata globosa, atro-brunnea vel subnigra, 25.0-54.0 μm diam. Conidiophora laxe vel dense fasciculata, olivacea vel pallide griseo-brunnea, erecta vel curvata, geniculata, non ramosa, 0-4-septata, 11.0-43.0 (-58.4) × 3.2-4.3 μm. Conidia acicularia, olivacea vel pallide olivaceo-brunnea, erecta, valde curvata vel sigmoidea, ad apicem subacuta vel obtusa, ad basim truncata, indistincte 3-10-septata, 47.5-104.0 × 2.4-3.2 μm.

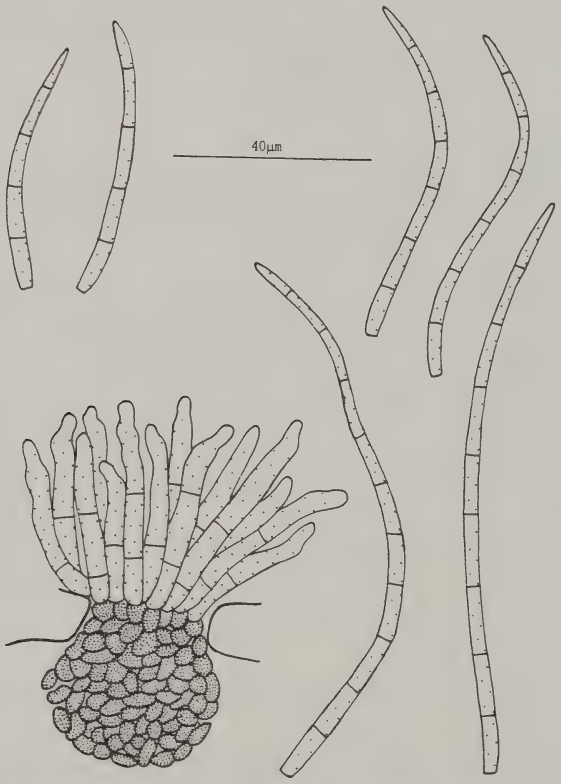

Fig. 1 *Pseudocercospora mytilariae* Y. L. Guo

Hab. in foliis vivis *Mytilariae laosensis* Lec.: China, Fengkai, Guangdong Provincia, 28 X 1998, leg. Guo YL, no. 385 (HMAS 79135, Holotypus).

Leaf spots amphigenous, subcircular to angular, 0.5-2.0 mm wide, sometimes confluent, dark brown, grayish brown to blackish brown, with pale yellowish brown to grayish green halo on the upper surface, purplish brown, deeply grayish brown to blackish on the lower surface. Fruiting amphigenous. Mycelium immersed. Stromata substomatal, globose, dark brown to blackish, 25.0-54.0 μm diam. Conidiophores loosely to densely fasciculate, olivaceous to pale grayish brown, paler towards the apex, irregular in width, straight to curved, geniculate, not branched, rounded, conical to truncate at the apex, 0-4-septate, 11.0-43.0 (-58.4) × 3.2-4.3 μm. Conidia acicular, olivaceous to pale olivaceous brown, straight, curved to sigmoid, subacute to obtuse at the apex, truncate at the base, indistinctly 3-10-septate, 47.5-104.0 × 2.4-3.2 μm.

Pseudocercospora liquidambaris Sawada ex Goh & W. H. Hsieh (1990) on *Liquidambar* spp. differs from the new species in possessing paler (very pale olivaceous), shorter conidiophores (4.0-19.5 × 2.0-4.0 μm), and narrowly obclavate to linear, pale (subhyaline to pale olivaceous), shorter conidia (20.0-86.5 × 2.0-4.0 μm), with obconically truncate base.

Cercospora corylopsidis Togashi & Kats. on *Corylopsis pauciflora* Sieb. & Zucc. and *Mycovellosiella hamamelidis* (Peck) U. Braun (Crypt. Bot. 3: 237, 1993) on *Hamamelis* spp. have narrower conidiophores (the former 5.0-30.0 × 3.0-4.0 μm, the latter 10.0-75.0 × 2.0-3.5 μm) and conidia (the former 30.0-75.0 × 2.0-4.0 μm, the latter 15.0-60.0 × 1.5-3.0μm).

Pseudocercospora schefflericola Y. L. Guo, sp. nov. Fig. 2

Maculae amphigenae, orbiculares vel suborbiculares, 2.0-5.0 mm diam., griseo-albae vel flavo-brunneae. Caespituli hypogeni. Mycelium immersum. Stromata substomatalia, subglobosa, brunnea, 20.0-50.0 μm diam. Conidiophora laxe vel dense fasciculata, pallide vel moderate olivaceo-brunnea, erecta vel curvata, leviter geniculata, non ramosa, 1-7-septata, 19.5-97.3 × 4.8-6.0(-7.0) μm. Conidia cylindrica, pallide vel modice olivaceo-brunnea, erecta, valde curvata, etiam "U", "V" vel "S" formata, ad apicem late rotundata, ad basim truncata, 5-14-septata, interdum constricta, 40.0-98.0 (-152.0) × 6.5-9.8 μm.

Hab. in foliis vivis *Schefflerae* sp.: China, Xinyi, Guangdong Provincia, 22 X 1998, leg. Guo YL, no.331 (HMAS 79136, Holotypus).

Leaf spots amphigenous, circular to subcircular, hemi-circular at the margin, 2.0-5.0 mm diam., sometimes confluent, grayish white to pale yellowish brown, margin surrounded by a brown line, with yellowish green to pale yellow halo on the upper surface, grayish white to yellowish brown on the lower surface. Fruiting hypogenous. Mycelium immersed. Stromata substomatal, subglobose, brown, 20.0-50.0 μm diam. Conidiophores a few emerging through the stomata or loosely to densely fasciculate on the stromata, pale to moderately olivaceous brown, paler towards the apex, irregular in width, straight to curved, slightly geniculate, not branched, rounded to conical at the apex, 1-7-septate, sometimes constricted, 19.5-97.3 × 4.8-6.0(-7.0) μm. Conidia cylindrical, pale to medium olivaceous brown, straight to strongly curved, even "U"-, "V"- or "S"-shaped, broadly rounded at the apex, truncate at the base, 5-14-septate, sometimes constricted, 40.0-98.0 (-152.0) × 6.5-9.8 μm.

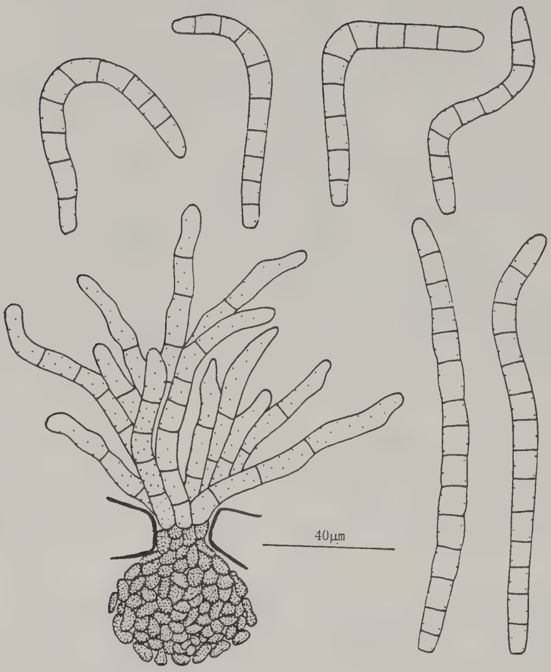

Fig. 2 *Pseudocercospora schefflericola* Y. L. Guo

Pseudocercospora schefflerae Goh & W. H. Hsieh (1990) on *Schefflera octophylla* (Lour) Harms. differs from the new species in having darker (pale brown to brown), geniculate, denticulate, narrower conidiophores (30.0-100.0 × 3.0-5.0 μm), and paler (olivaceous to pale olivaceous brown), narrower conidia (45.0-100.0 × 4.0-5.0 μm) with obconically truncate base.

Pseudocercospora araliae (P. Henn.) Deighton (1976) on *Aralia* spp. is different from this species in having effuse fruiting, longer conidiophores (77.5-200.0 × 4.0-7.3 μm), and obclavate-cylindrical, narrower conidia (32.5-105.0 × 4.5-7.0 μm) with obconically truncate base,

Spiropes capensis (Thüm.) M. B. Ellis, Mycol. Pap. 114: 5, 1968.

Conidiophores solitary to 2-10 in groups, dark brown, 3-multiseptate, 60.0-200.0 × 5.4-7.0 μm. Conidia obclavate to fusiform, olivaceous, 3-6-septate, 32.0-54.0 × 6.5-9.0 μm.

On *Miscanthus floridulus* (Lebill.) Warb.: Fengkai, Guangdong Province (HMAS 79126).

Ellis (1968) described this fungus with brown to dark brown conidiophores, up to 500.0 μm long, 6.0-8.0 μm wide, and fusiform to obclavate conidia, subhyaline to brown, 3-6-septate, 38.0-67.0 × 6.0-11.0 μm. The conidiophores and conida of the Chinese collection are shorter and narrower than those in the original description.

Spiropes effusus (Pat.) M. B. Ellis, Mycol. Pap. 114: 10, 1968.

Conidiophores solitary to 2-4 in groups, dark brown, up to 260.0 μm long, 4.3-5.4 μm wide. Conidia narrowly obclavate, olivaceous, 1-5-septate, 25.0-55.0 × 3.7-4.3 (-5.4) μm.

On *Ficus fistulosa* Reinw.: Huidong, Guangdong Province (HMAS 79127).

Spiropes harunganae (Hansf.) M. B. Ellis, Mycol. Pap. 114: 39, 1968.

Conidiophores solitary, dark brown, 1-10-septate, 40.0-195.0 × 5.4-6.5 μm. Conidia fusiform, pale olivaceous brown, 1-2-septate, 24.0-35.0 × 8.0-9.5 μm.

On *Castanopsis* sp.: Xinyi, Guangdong Province (HMAS 79128).

According to Ellis (1968), the conidiophores of *Spiropes harunganae* (Hansf.) M. B. Ellis are brown to dark brown, up to 500.0 μm long, 6.0-9.0 μm wide, and the conidia are obclavate, pale brown to brown, 1-3-septate, 30.0-46.0 × 8.0-12.0 μm. In the Chinese material, the conidiophores and conida are shorter and narrower than those described by Ellis.

Stenella alocasiae Sarbajna & Chattopadh., Journ. Mycopathol. Res. 29(1): 33, 1991.

Fruiting amphigenous. Secondary mycelium external: hyphae pale olivaceous, verruculose, branched, septate, 2.0-3.0 μm wide. Stromata substomatal, brown. Conidiophores loosely fasciculate, olivaceous to pale olivaceous brown, 0-5-septate, 10.0-65.0 × 4.0-6.5 μm. Conidial scars conspicuous, 1.2-1.5 μm wide. Conidia catenate, cylindrical, pale olivaceous to pale olivaceous brown, septa indistinct, up to 195.0 μm long, 3.2-4.3 μm wide.

On *Alocasia* sp.: Baoting, Hainan Province (HMAS 80312).

Stigmina sapii (Miyake) M. B. Ellis, Mycol. Pap. 114: 42, 1968.

Stromata 20.0-35.0 μm diam. Conidiophores pale brown, with 0-5-annellations, 20.0-38.0 × 3.2-5.4 μm. Conidia obclavate, moderately brown, smooth, straight to curved, with 2-8 transverse septa, sometimes with a single oblique or longitudinal septum, 20.0-50.0 × 6.5-8.5 μm.

On *Sapium sebiferum* (L.) Roxb.: Fengkai, Guangdong Province (HMAS 79130).

Tomenticola trematis Deighton, Mycol. Pap. 117: 20, 1969.

Mycelium superficial: hyphae olivaceous brown, 2.2-2.5 μm wide. Conidiophores solitary or 2-4 in a fascicle, pale brown to brown, straight to slightly curved, truncate at the apex, 0-3-septate, 11.0-65.0 × 5.4-7.5 μm. Conidia obclavate, pale brown, straight to curved, broadly rounded at the apex, obconically truncate at the base, 3-4-septate, 26.0-54.0 × 11.0-13.0 μm.

On *Trema dielsiana* Hand.-Mazz.: Fengkai, Guangdong, Province (HMAS 79131).

Deighton (1969) described *Tomenticola trematis* Deighton with conidiophores up to 450.0 μm long, 4.0-7.0 μm wide and conidia 1-24-septate, 23.0-360.0 × 9.0-15.0 μm. In the Chinese specimen the conidiophores and conidia are shorter than those in Deighton's description.

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中国热带真菌新种和新记录种：丝孢菌

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摘要：本文报道中国热带地区 11 种丝孢菌，其中有两个新种：壳菜果假尾孢 *Pseudocercospora mytilariae* Y. L. Guo，寄生在金缕梅科 Hamameliaceae 的壳菜果 *Mytolaria laosensis* Lec.上，鹅掌柴生假尾孢 *Pseudocercospora scheffiericola* Y. L. Guo，寄生在五加科 Araliaceae 的鹅掌柴属 *Schefflera* sp. 植物上和 9 个中国新记录种。*Tomenticola* Deighton 为中国新记录属。文中为新种提供了拉丁文简介并绘图。研究的标本保存在中国科学院微生物研究所菌物标本馆（HMAS)。

关键词：假尾孢属，壳菜果假尾孢，鹅掌柴生假尾孢。

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XANTHORIA NOWAKII SP. NOV. (TELOSCHISTACEAE, LICHENIZED ASCOMYCOTA), A NEW EPILITHIC LICHEN SPECIES

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ABSTRACT. Unique by the very minute size of the thallus and all its structures, *Xanthoria nowakii* S. Kondratyuk & U. Bielczyk is described and illustrated. This species occurs in Europe (Poland, Switzerland) and South America (Chile) and grows on calcium-containing rock substrate. Its ecology is described and a comparison to the closest species, *X. candelaria* and *X. ucrainica* is provided.

Key words: Xanthoria, Poland, Switzerland, Chile, new species.

INTRODUCTION

The last decades of the 20th century are characterised by the rather intense interest and taxonomical study of some species groups of the genus *Xanthoria*. Recently described or combined Xanthorias, as shown in Table 1, are both epiphytic and epilithic.

Table 1. *Xanthoria* species described during the second half of 20th century

Ecological groups	Species	Source
Epiphyte	*Xanthoria africana* Almborn	Almborn 1963
	Xanthoria alfredii S. Kondratyuk & Poelt	Kondratyuk & Poelt 1997
	Xanthoria aphrodites Kalb, Poelt & S. Kondratyuk	Kondratyuk & Poelt 1997
	Xanthoria ascendens S. Kondratyuk	Kondratyuk 1997
	Xanthoria borealis R. Santesson & Poelt	Poelt & Petutschnig 1992
	Xanthoria concinna Thomson & Nash	Thomson & Nash 1976
	Xanthoria filsonii Elix	Elix 1988
	Xanthoria fulva (Hoffm.) Poelt & Petutschnig	Poelt & Petutschnig 1992
	Xanthoria gallowayii S. Kondratyuk & Kärnefelt	Kondratyuk & Kärnefelt 1997a
	Xanthoria montana L. Lindblom	Lindblom 1997
	Xanthoria poeltii S. Kondratyuk & Kärnefelt	Kondratyuk & Kärnefelt 1997b
	Xanthoria tenax L. Lindblom	Lindblom 1997
	Xanthoria ucrainica S. Kondratyuk	Kondratyuk 1997
Epilite	*Xanthoria mediterranea* Giralt, Nimis & Poelt	Giralt, Nimis & Poelt 1993
	Xanthoria alaskana Thomson	Talbot, Talbot & Thomson, 1992
	Xanthoria australis (Zahlbr.) Dodge	Dodge 1965
	Xanthoria capensis Kärnefelt, Arup & Lindblom	Kärnefelt, Arup & Lindblom 1995
	Xanthoria ectanea (Ach.) Ras. ex Fils.	Filson 1969
	Xanthoria isidioidea (Beltr.) Trass	Trass 1973
	Xanthoria ligulata (Körb.) P. James	Galloway 1983
	Xanthoria mandshurica Asahina	Asahina 1954
	Xanthoria microspora B. de Lesd.	Bouly de Lesdain 1957
	Xanthoria muscicola (Lojka, Suza ex Sav.) Vězda	Vězda 1969
	Xanthoria papillifera (Vain.) Poelt	Poelt 1954
	Xanthoria resendei Poelt & Tavares	Poelt & Tavares 1968
	Xanthoria scandinavica B. de Lesd.	Bouly de Lesdain 1959
	Xanthoria siplei (Dodge & Baker) Dodge	Dodge 1973
	Xanthoria sorediata (Vain.) Poelt	Poelt 1954
	Xanthoria stiligera Giralt, Nimis & Poelt	Giralt, Nimis & Poelt 1993
	Xanthoria subelegans (Nyl.) Tav. & Poelt	Tavares 1964

Until now, however, among epilithic lichens, there were species mainly of the *X. elegans* group (*X. capensis*, *X. mandshurica*, *X. papillifera*, *X. resendei*, *X. sorediata*, *X. stilligera*, *X. subelegans* etc.) and *X. parietina* group (*X. australis*, *X. ligulata*, *X. mediterranea*, *X. muscicola* etc.).

X. candelaria s. l. has hitherto included a complex of sorediate taxa owing to lack of type material. Recent selection of neotype of this species (Moberg 1986) has allowed to clarify the position of other taxa earlier included in *X. candelaria* s. l. So *X. ucrainica* and *X. poeltii* are segregated from the complex (Kondratyuk 1997; Kondratyuk & Kärnefelt 1997b) .

During the first author's investigation of materials from several European herbaria (LD, E, LE, KW, BRA, KRAM-L, KRAP-L) while working on a key to Eurasian Xanthorias, some problematic taxa of the *X. candelaria* group were discovered. Of these, two taxa with very tiny thalli proved to be undescribed. To further clarify the taxonomic position of those representatives of the *X. candelaria* group, one of them, namely *X. nowakii*, is described and illustrated here.

MATERIAL AND METHODS

The taxon described below as *Xanthoria nowakii* became known to the first author from single herbarium specimen from South America (LD in 1996). It was then found to occur in Poland as well (KRAM-L in 1999). However, an insufficient amount of herbarium material and a poor knowledge of the species ecology did not previously allow for the description of this taxon. Fortunately, an important up-to-date collection of this species in the field was performed in Switzerland during a post-LICON excursion organised by Dr. Scheidegger in 1999. Consequently, this locality became the *locus classicus* for taxon described.

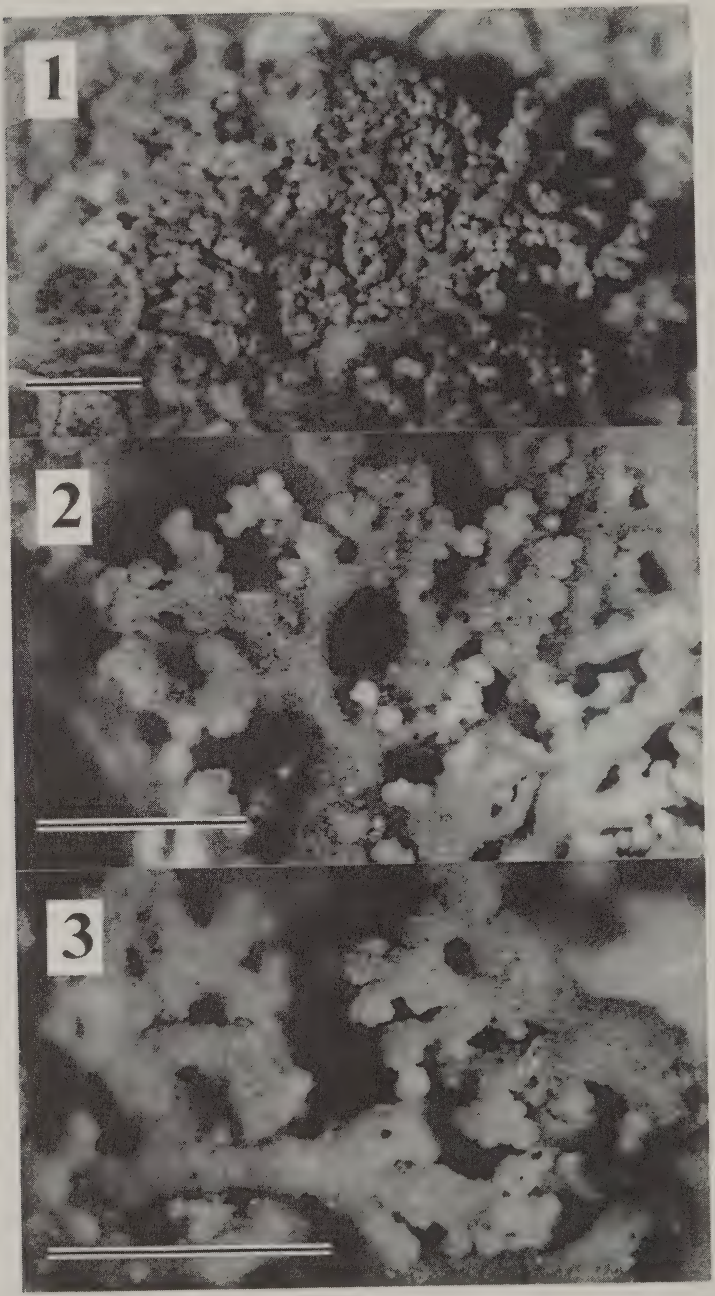
For the specimens examined, the standard methods of the cameral treatment of lichen specimens were applied. A dissecting microscope -Nikon SMZ-10A- was used for microphotographs as well as for line drawings.

Herbarium acronyms used in the paper are in accordance with Holmgren *et al*. (1990) and Mirek *et al.* (1997).

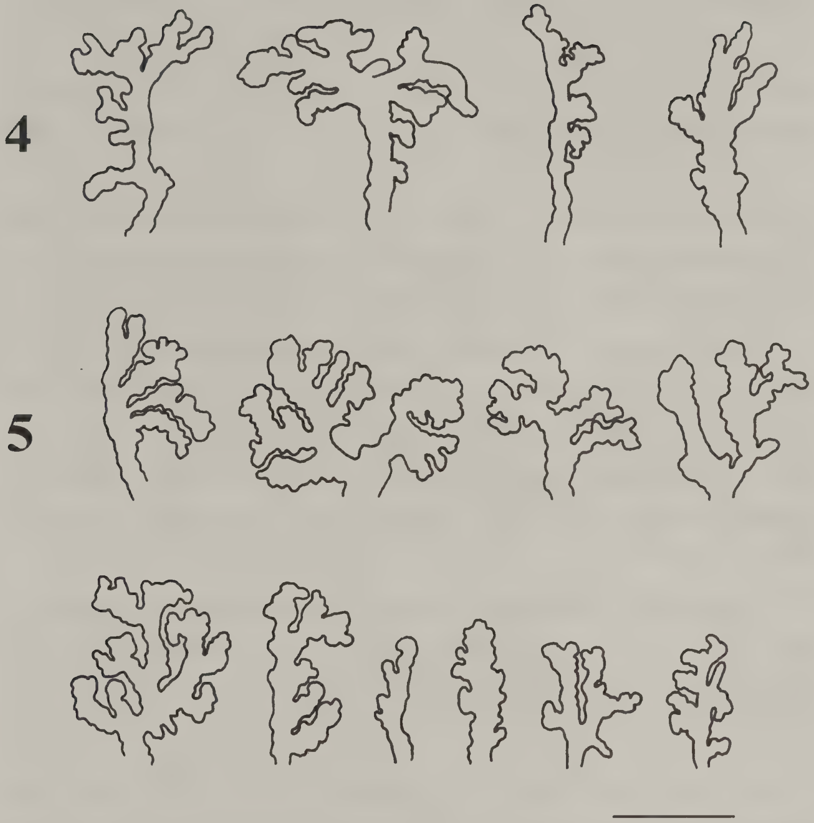
RESULTS

Xanthoria nowakii S. Kondratyuk & U. Bielczyk *sp. nov.* Figs 1-5

Planta saxicola, subsimilis Xanthoriae candelariae *a qua differt thallis minutissimis et lobis 75-125(-210) µm latis, apicibus conblastidia gerentibus vulgo ascendentibus. Apothecia et spermogonia ignota.*



Figs. 1-3. *Xanthoria nowakii*, holotype (KW). Fig. 1. General habitus. Figs. 2 & 3. Enlarged part of the lobe. Bar = 0.5 mm.



Figs. 4-5. *Xanthoria nowakii*, holotype (KW). Fig. 4. Separate lobes. Fig. 5. Terminal fragments of the lobe. Bar = 0.5 mm.

TYPE: SWITZERLAND: Alps, near Silvaplana Lake, opposite of Silvaplana valley, locality Surlej, near Surley River with waterfall, 9°48’22’’E, 46°27’22’’N (national coordinates 782.2/147.1), at 1940 m alt., on calcium containing rocks, 4 ix 1999, *S. Kondratyuk, C. Scheidegger, G. Kantvilas* and *T. Goward* 9963 (KW- holotype, GZU, KRAM-L, LD – isotypes).

DESCRIPTION: *Thallus* very tiny, (1.2–)1.4–3.4(–5.1) mm across, with a single rosette of radiating horizontally orientated lobes (1.5–2 mm across) or very often in aggregations of ascending lobes (3–4 mm across); yellow-orange to brownish-orange or dark reddish-orange, epruinose or with a slightly developed layer of white pruina, always erhizinose, scarcely blastidiosus on the lower surface. Lower side whitish (mainly in horizontally orientated lobes) or concolorous with upper surface (in vertically orientated lobes), to bright yellow in blastidious zone. *Lobes* very small, (0.16–)0.3–0.8(–1.4) mm long and 75–125(–210) μm wide, somewhat flattened at the base and cylindrical at the tips; sometimes separate lobes richly branched at the tips, in this case, total width of lobe (200–)250–600(–800) μm, but width of the single lobules at the base (75–)140–200 μm. *Blasidia* mainly on the lower surface, sometimes very abundant, yellow (without orange tint, much lighter than thallus colour), spherical, (15–)20–25(–40) μm diam. Blastidia-like fragments (conblastidia?) segregated at the margin of the lobes, (30–)40–60 μm diam., sometimes forming characteristic monilia-like chains at the tips of the lobes. In vertical section, thallus 80–90 μm thick (distinctly dorsiventral at the base and with somewhat radial structure at the tips). Both *cortical layers* paraplectenchymatous consisting of cells with thickened walls, 4–10 μm across, slightly elongated in a vertical direction. Upper cortical layer 12–15 μm thick, with brightly yellow brownish epicortex, 3–5 μm thick. *Algal layer* continuous. *Algae* spherical, (6–)10–18 μm diam. *Medulla* rather compact 50-60 μm thick. Lower cortical layer 12–15 μm thick. *Apothecia* and *spermogonia* unknown.

ETYMOLOGY: *Xanthoria nowakii* is named after the eminent Polish lichenologist, Prof. Janusz Nowak, for his important contributions to the knowledge of Polish lichen flora and to the development of the lichenology in this country, as well as to honour his 70th birthday.

ECOLOGY AND DISTRIBUTION: *Xanthoria nowakii* was collected in non-shaded places of north facing slopes of a rather large vertical surface of rock outcrop not far from a waterfall and coniferous forest. It is associated with *Buellia alboatra* (Hoffm.) Th.Fr., *Caloplaca cirrochroa* (Ach.) Th.Fr., *C. citrina* (Hoffm.) Th.Fr., *C. saxicola* (Hoffm.) Nordin, *Caloplaca* sp. [comparable with epiphyte species *C. chrysophthalma* Degel.], *Candelariella aurella* (Hoff.) Zahlbr., *Lecania* sp., *Lecanora crenulata* Hook., *Lecanora dispersa* (Pers.) Sommerf., *Ochrolechia* sp., *Phaeophyscia kairamoi* agg., *P. nigricans* (Harm.) Moberg, *Physcia caesia* (Hoffm.) Fürnrohr., *P. dimidiata* (Arn.) Nyl., *Physconia* sp., *Sarcogyne* sp., *Xanthoria elegans* (Link) Th.Fr. and others. In shaded conditions on north-eastern face of the same rock cliff, *Caloplaca flavovirescens* (Wulf.) Dalla Torre & Sarnth., *C. obliterans* (Nyl.) Blomb. & Forssell, *Collema* sp., *Lobaria scrobiculata* (Scop.) DC., *Pertusaria coccodes* (Ach.) Nyl., *Synalissa* sp., *Xanthoria sorediata* etc. were recorded. It is worth noting that some of the lichen species associated with the type specimen, are abundantly parasitised; in holotype specimen (KW) *Lecanora dispersa* is strongly damaged by the lichenicolous fungus *Zwackhiomyces sphinctrinoides* (Zwackh.) Grube & Hafellner; in isotype specimen (KRAM-L) *Lecanora crenulata* is strongly damaged by *Muellerella pygmaea* (Körb.) D. Hawksw.

Xanthoria nowakii is, to date, known from two distant localities in Europe (Poland, Switzerland) and one from South America (Chile). Perhaps further revision of the *X. candelaria* group will add new data regarding its distribution.

REMARKS: The new species, *X. nowakii*, is characterised by a very small thallus consisting of horizontal or ascending very narrow lobes, which are blastidious on the underside, and produce terminal conblastidia. With these characteristics it is easily distinguished from other related species. It combines features of both *X. candelaria* (the same cushion-like thallus, not quite radial structure of the terminal parts of the lobes, thallus colour etc.) and *X. ucrainica* (small size) (Table 2). *X. nowakii* may, on the first impression, be taken for a young *X. candelaria*. However, it differs mainly by the much smaller thallus, very thin terminal portions of lobes and by monilia-like chains of the conblastidia on their tips. From field observation, it also cannot be considered an initial stage of *X. candelaria*. In type locality, the latter species was not found on the same rock surface at all.

From *X. ucrainica* the new species differs by its very narrow lobes (in *X. ucrainica* they are 0.7–1.0 mm wide), which are somewhat cylindrical at the tips, the evenly pigmented thallus (non-variegated pigmentation of upper surface of thallus) and by the presence of conblastidia which sometimes form monilia-like tips. *X. ucrainica* was found not far from the type locality of *X. nowakii* in Switzerland.

Table 2. Comparison between *Xanthoria candelaria*, *X. nowakii*, and *X. ucrainica**

Character	*X. candelaria*	*X. nowakii*	*X. ucrainica*
Thallus	Subfruticose	Foliose to subfruticose	Distinctly foliose
	Vertical compact clusters	Horizontal with ascending single lobes or aggregations	Umbilicate to minutely scaly
	Mainly more or less radially built	Mainly distinctly dorsiventral at the base and almost radial at the tips	Distinctly dorsiventral
(cm diam.)	up to 2	0.1–0.3(–0.5)	0.3–0.4
Colour of the upper surface	Evenly pigmented	Evenly pigmented	More or less whitish in the central part
	Yellow-orange to reddish-orange	Yellow, yellow-orange to red-orange	Lemon -yellow to citron-green
[In herbarium]	Yellow-orange	Yellow-orange	Yellowish grey
Lobes			
(mm long)	0.6–1.0(–1.5)	0.3–0.8(–1.4)	0.7–1.2(–1.7)
(mm wide)	0.1–0.3(–0.5)	0.07–0.12–(0.2)	0.7–1.0(–1.2)
Rhizines	Absent	Absent	Absent
Blastidia	Along the margins and on the lower surface	Along the margins and on the lower surface, rarely on the upper surface	Along the margins and on the lower surface
(μm diam.)	25–35	20–30(–40)	(35–)40–60(–65)
Conblastidia (μm diam.)	(40–)45–70(–110)	60–85(–100)	Absent
Spermatia	Ellipsoid	Unknown	Broadly elliptical
(μm)	2.5–3 x 1.0–1.5		2.2–2.5(–3.1) x 1.2–1.5(–1.8)

* Results of own study of the type material of *X. candelaria*, and *X. ucrainica* are used during this investigation.

OTHER SPECIMENS EXAMINED: POLAND: Western Tatry (Tatry Zachodnie): Dolina Małej Łąki valey, Szpiczasta Turnia Mt., 1500 m alt., calcium containing rock, 4 vi 1929 *J. Motyka* (KRAM-L-44840, ZAMU - dupl.) – CHILE: Prov. Coquimbo: La Serena. East of the town, on rocks in dry hillside, 29 vi 1940 *R. Santesson* 2601 (S-95-148).

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MYCOTAXON

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NOTES ON HYPHOMYCETES. LXXX. PARAHAPLOTRICHUM IDAHOENSE, A NEW GENUS AND SPECIES POSSIBLY BELONGING TO THE BOTRYOBASIDIUM ANAMORPH COMPLEX

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ABSTRACT

A new monotypic genus, *Parahaplotrichum*, is established based upon a collection made some eighty-one years ago on decorticated wood in Idaho, housed in the U.S. National Fungus Collections, but originally misidentified as *Oospora fulva* [= *Haplotrichum dubium*]. It is described and illustrated.

KEYWORDS: *Allescheriella*, generic concepts.

INTRODUCTION

During the course of examination of a number of herbarium specimens whilst conducting a study of taxa belonging to the *Acladium-Alysidium-Haplotrichum* complex (Partridge *et al.*, 2001), it has become apparent that there have, over the years, been more than a few occurrences of misidentification of collected material. This is, perhaps, not surprising given the fact that many of the species involved are somewhat similar in their morphology, and the distinguishing characteristics of some have never been adequately or entirely documented. As an example, even *Allescheriella crocea* (Mont.) S. Hughes, the anamorph of *Botryobasidium croceum* Lentz, although distinctive enough to merit classification in a separate genus because it produces aleuriospore-like conidia, has been confused with *Haplotrichum simile* (Berk.) Hol.-Jech., the anamorph of *Botryobasidium simile* Pouz. & Hol.-Jech. Several collections of the former have, in fact, been encountered under incorrect names. A mention of these will be made in a forthcoming publication. Among material housed at the U.S. National Fungus Collections (BPI), a specimen determined and labelled as *Oospora fulva* (Kunze) Sacc. [a facultative synonym of *Haplotrichum dubium* (Pers.) W.A. Baker & Partridge], collected in Idaho early in the last century, has been found not to be this species, but rather, apparently, a hitherto undescribed entity. Although similar in habit, substrate, and colony characteristics, including color, to species of *Haplotrichum* Link, and morphologically to some other genera such as *Xylohypha* (Fr.) Mason, the fungus is sufficiently different in several respects to warrant classification in its own genus. It is named, described, and illustrated herein.

TAXONOMIC PART

Parahaplotrichum W.A. Baker et Partridge, gen. nov.

Coloniae effusae, densae, resupinatae, hypochnoideae, pulveraceae, cacao-brunneae. Mycelium plerumque superficiale, ex hyphis ramosis, septatis, laevibus, repentibus, hyalinis vel sub-hyalinis compositum. Conidiophora semi-macronemata, mononemata, saepe caespitosa, adscendentia, erecta, simplicia vel ramosa, plerumque flexuosa, cylindrica, laevia, septata, hyalina ad luteola. Cellulae conidiogenae mono- vel polyblasticae, in conidiophoris incorporatae, terminales vel interdum intercalares, leniter denticulatae. Conidia acropleurogena, holoblastica, in catenis simplicibus vel ramosis, acropetis formata, sicca, aseptata, laevia, fusiformia vel limoniformia, sub-hyalina ad luteola.
Species typica *Parahaplotrichum idahoense* W.A. Baker & Partridge.

Parahaplotrichum W.A. Baker & Partridge, gen. nov.

Colonies effuse, dense, resupinate, hypochnoid, powdery, chocolate brown in color. Mycelium mostly superficial, composed of branched, septate, interweaving, smooth, repent, hyaline to sub-hyaline hyphae, often forming a somewhat pulvinate subiculum. Conidiophores semi-macronematous, mononematous, frequently densely caespitose, ascending, erect, simple or often branched, mostly flexuous, cylindrical, smooth, septate, hyaline to very pale yellowish-brown. Conidiogenous cells mono- or polyblastic, integrated, intercalary or predominantly terminal, slightly denticulate. Conidia acropleurogenous, holoblastic, in simple or mostly branched acropetal chains, dry, unicellular, smooth, fusiform to somewhat limoniform, sub-hyaline to very pale yellowish.

Etymology: Gr. *para*, similar to/near, et *Haplotrichum*.

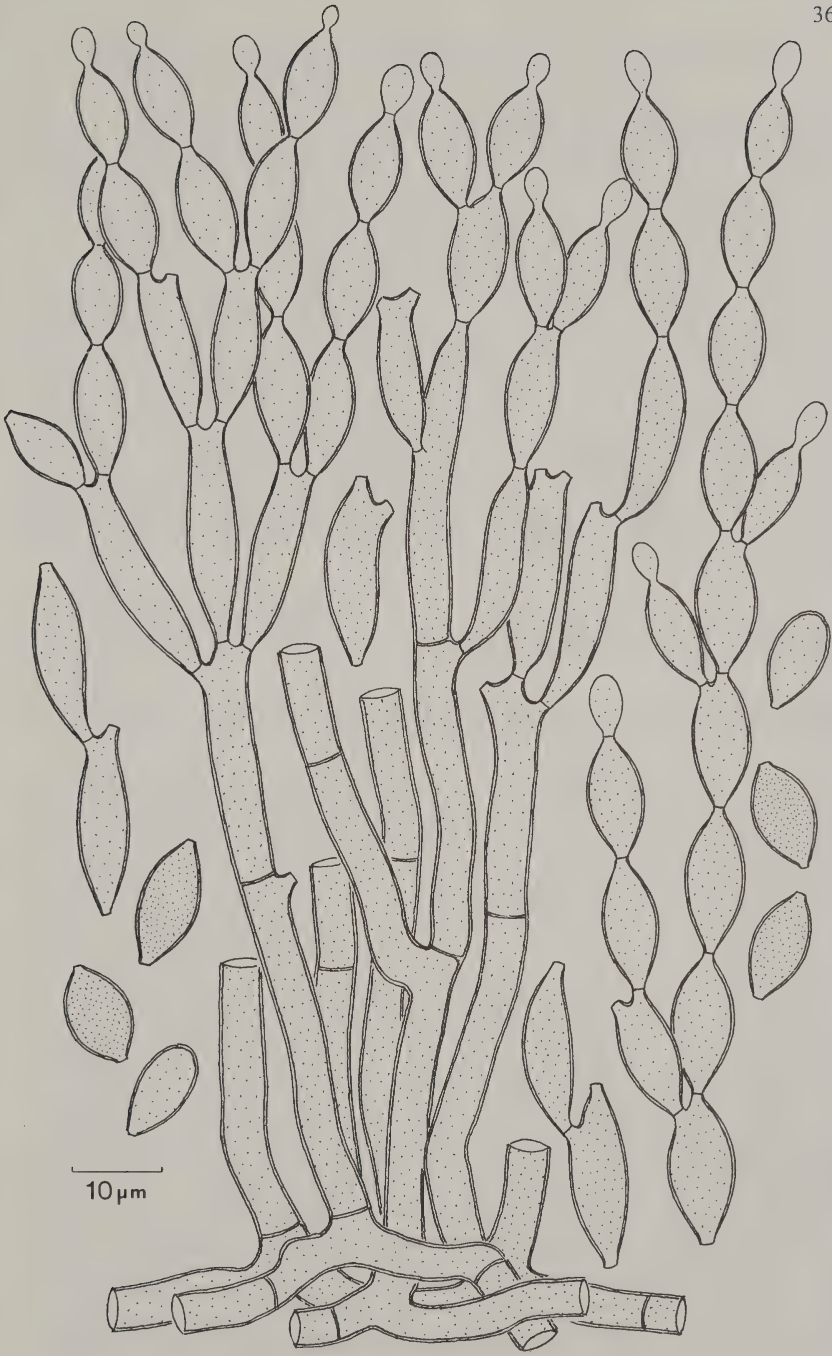

FIGURE 1. *Parahaplotrichum idahoense*. Conidiophores and conidia.

Parahaplotrichum idahoense W.A. Baker et Partridge, sp. nov.

Coloniae extense effusae, resupinatae, hypochnoideae, densae, velutinae et pulveraceae, pallide ad medio cacao-brunneae. Mycelium plerumque superficiale, ex hyphis ramosis, septatis, repentibus, laevibus, hyalinis vel sub-hyalinis, 2-4 µm crassis compositum. Conidiophora semi-macronemata, mononemata, laxe vel dense caespitosa, adscendentia, erecta, simplicia vel ramosa, plerumque flexuosa, cylindrica, laevia, sparsa septata, satis crassi tunicata, hyalina ad luteola, usque ad 100 µm longa, 2-5 µm crassa. Cellulae conidiogenae mono- vel polyblasticae, in conidiophoris incorporatae, determinatae, plerumque terminales, interdum intercalares, cylindricae, leniter denticulatae. Conidia acropleurogena, holoblastica, in catenis simplicibus vel ramosis, acropetis formata, sicca, aseptata, laevia, satis crassi tunicata, plerumque fusiformia vel limoniformia, sub-hyalina ad luteola, 7-12 µm longa, 3-5 µm crassa; ramoconidia fusiformia, denticulata, 13-16 µm longa, 3-5 µm crassa.

In ligno emortuo, Coolin, Idaho, USA, J.R. Weir, 20 September 1919, [as *Oospora fulva* (Kunze) Sacc.] BPI, holotypus.

Parahaplotrichum idahoense W.A. Baker & Partridge, sp. nov. (Figure 1).

Colonies widely effuse, spreading, resupinate, hypochnoid, becoming somewhat dense, velvety, and powdery, pale- to mid-chocolate brown in color. Mycelium mostly superficial, composed of branched, septate, loosely interweaving, repent, smooth, mostly hyaline to sub-hyaline, 2-4 µm wide hyphae, often forming a somewhat pulvinate subiculum. Conidiophores semi-macronematous, mononematous, densely caespitose, ascending, more or less erect, simple or branched, branches generally assuming a parallel orientation relative to one another, mostly flexuous, cylindrical, smooth, sparsely septate, fairly thick-walled, hyaline to pale-yellowish, mostly up to 100 µm long, occasionally longer, 2 -5 µm wide. Conidiogenous cells mono- or polyblastic, integrated, determinate, mostly terminal, occasionally intercalary, cylindrical, bearing short, stubby denticles at conidiation loci, varying in length. Conidia acropleurogenous, holoblastic, in mostly very long, simple or branched acropetal chains, dry, unicellular, smooth, fairly thick-walled, predominantly broadly fusiform to somewhat limoniform and slightly apiculate at one or both ends, sub-hyaline to pale-yellowish, 7-12 X 3-5 µm; ramoconidia, especially those formed at the proximal ends of the conidial chains, sometimes fusiform with two to three denticles in the distal portion, 13-16 X 3-5 µm.

On decaying wood; North America.

Specimen examined: Coolin, Idaho, USA, J.R. Weir, 20 September 1919, [as *Oospora fulva* (Kunze) Sacc.] BPI, holotype.

DISCUSSION

A new genus is being established for this anamorph advisedly since there is some reason to believe that it may belong to the *Botryobasidium* Donk anamorph complex, most members of which are now classified in the genus *Haplotrichum* [see Eriksson (1958); Holubová-Jechová (1980); Langer (1994); Partridge *et al.* (loc. cit.)]. With due respect for the genus-for-genus taxonomic philosophy, however, the morphological discontinuity and distance between *Parahaplotrichum idahoense* and those species classified in *Haplotrichum sensu stricto* is of sufficient magnitude to dictate separate recognition. In light of long-established generic concepts in the Hyphomycetes this entity is as uniquely different from any other as many taxa upon which form-genera have customarily been recognized and based. Given the fact that the type and only species of *Allescheriella* P. Henn., *A. crocea* [*A. uredinoides* P. Henn.], as noted above, is the anamorph of *Botryobasidium croceum*, it is already accepted that the range of morphology extant among mitosporic states of *Botryobasidium* cannot be satisfactorily contained within a single genus. To accommodate *A. crocea* and *P. idahoense* within *Haplotrichum* would unduly extend what have traditionally been the limits set for generic circumscription. The teleomorph of *P. idahoense*, as is the case in such species of *Haplotrichum* as *H. album* (Sumstine) Hol.-Jech., *H. ochraceum* (Povah) Hol.-Jech., and *H. ramosissimum* (Berk. & Curt.) Hol.-Jech., is at present unknown.

The assumption that *P. idahoense* may belong to the *Botryobasidium* anamorph complex is based upon the close similarity between its colony characteristics and coloration and those which are typical of both *Allescheriella crocea* and *Haplotrichum* species. In addition, the repent, interweaving growth pattern of its hyphae and their relative width are comparable to those of the latter taxa. In possessing sub-hyaline to pale-yellowish conidia, and denticulate conidiogenous cells, it resembles several members of *Haplotrichum*. However, *P. idahoense* differs notably in several respects. Among these are the densely caespitose arrangement of the conidiophores which often results in the fertile tufts assuming a somewhat sporodochial aspect, the overall conidiophore morphology, presence of long conidial chains, and, particularly, the relatively small size of the conidia. Although bearing a broad similarity to some species of *Xylohypha*, such as *X.*

ferruginosa (Corda) S. Hughes and *X. novae-zelandiae* S. Hughes, *P. idahoense* is readily distinguishable from that genus, which has poorly developed or hardly differentiated conidiophores and appreciable conidial melanization.

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A NEW MUSCICOLOUS OMPHALINA WITH GLOBOSE BASIDIOSPORES FROM SPAIN[1]

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Key words: Agaricales, Tricholomataceae, *Pleurotus* fuscifrons, *Omphalina subglobispora,* taxonomy, Spanish mycota.

Abstract: *Omphalina subglobispora*, a new muscicolous species from Central Spain, is fully described, illustrated and discussed. It is characterized by its very small basidiomes, its globose, hyaline and smooth basidiospores, and its peculiar habitat (on gametophytes of mosses attached to living trees and rocks).

INTRODUCTION

The Mediterranean region, in particular the Iberian Peninsula, hosts a high diversity of fungi, many of them being endemic and associated with specific plants in its ecosystems. Although in recent years intensive mycological field work has been carried out in Spain, Southern France and Italy, the Mediterranean mycota still remaind poorly investigated. Consequently, new or rare species can regularly be discovered in all taxonomic groups of the Basidiomycota. In this contribution we present a new muscicolous *Omphalina* which, due to its small size and its peculiar habitat, is readily overlooked in the field.

The type material of *Omphalina subglobispora* is kept at the

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[1] This paper has been presented at the XIII Congress of European Mycologists, celebrated at the University of Alcalá de Henares (Madrid, Spain) the 21th-25th September 1999.

Herbarium of the University of Alcalá (AH), and isotype specimens have been deposited in the private herbarium of Prof. M. Bon in France.

***Omphalina subglobispora* G. Moreno, Heykoop & Horak, *sp. nov.* (nom. nov.) (Figs. 1-13)**

MISAPPLICATION: *Pleurotus fuscifrons* (Berk. & M.A. Curtis) Sacc., *Syll. Fung.* 5: 353. 1887. ss. J.E. Lange, *Flora Agaricina Danica* 2: 72, tab 65B. 1935; non *Agaricus fuscifrons* Berk. & M.A. Curtis, *J. Linn. Soc. Bot.* 10: 287. 1868, [Syn.: *Micromphale fuscifrons* (Berk. & M.A. Curtis) Murrill, *North Amer. Fl.* 9: 308. 1916. *Leptoglossum fuscifrons* (Fr.) M. Moser, *Kleine Krytogamenflora* IIb 2 (4th ed.): 127. 1978. (comb. inval.). *Agaricus pyrrhus* Berk. & M.A. Curtis, *J. Linn. Soc. Bot.* 10: 291. 1868. *Pyrrhoglossum pyrrhum* (Berk. & M.A. Curtis) Singer, *Mycologia* 36: 367. 1944. *Crepidotus pyrrhus* (Berk. & M.A. Curtis) Sacc., *Syll. Fung.* 5: 879. 1887.]

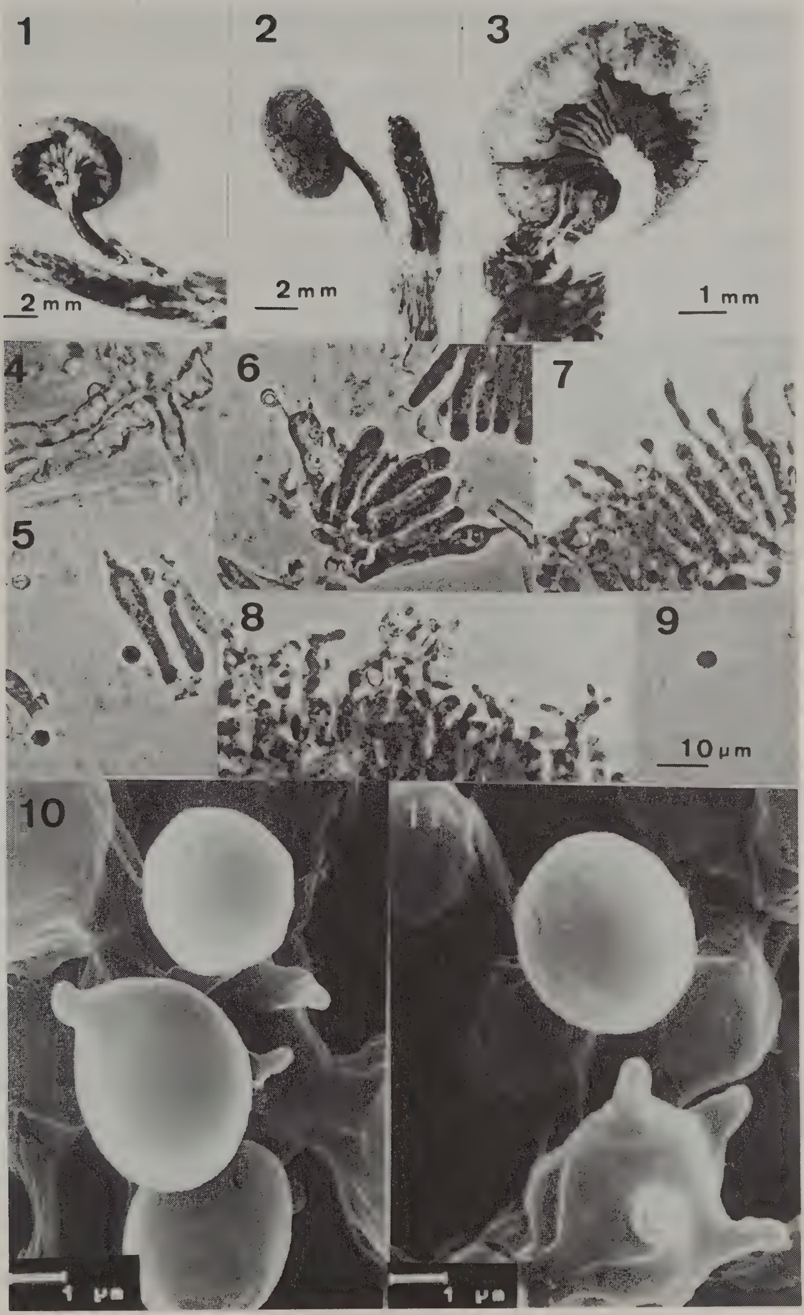
Pileus 2-5 mm latus, convexus vel in maturitate umbilicatus, fibrillosus, cinerascens, ad marginem involutus. Lamellae ca. 26 stipitem attingentes, decurrentes, saepe anastomosantes in juventute vel maturitate cinereae, lamellulae rarae praesentes. Stipes 4-7 x 1 mm, cylindraceus, centralis vel excentricus, cinerascens, in parte inferiore albidus. Odore saporeque nulli.

Basidiosporae 3,5-5 x 3,5-4,5 µm, globosae vel subglobosae, hyalinae, leves, nec amyloideae nec dextrinoideae. Basidia 24-28 x 5-6 µm, clavata, fibulata, 4-sporigera. Pleurocystidia nulla. Cheilocystidia sparsa, filiformia vel diverticulata apicem versus. Pileipellis ex hyphis cylindraceis cutem formantibus 4-7 µm latis, pigmento griseo-luteolo incrustatis, haud in materia gelatinosa immersis, fibulatis, constituta.

Ad muscos viventes (gametophyta) cum Arrhenia spathulata. Hispania. Holotypus: 19710 (AH).

Material studied: SPAIN: Prov. Huelva, Aracena, on living mosses (gametophytes) on rock, associated with *Arrhenia spathulata*, 16 Nov. 1997, *leg.* A. Burguete, L. Romero de la Osa & G. Moreno, AH 19710 Holotype. Prov. Guadalajara, Alto Tajo, on living mosses (gametophytes) on tree, Dec. 1997, *leg.* C. Illana, A. Altés & M. Heykoop, AH 19709.

Figs. 1-11.- *Omphalina subglobispora* G. Moreno, Heykoop & E. Horak: AH 19709 (paratype). 1, 2. Basidiomes growing on gametophytes of moss. AH 19710 (holotype). 3. Decurrent lamellae on pileus. 4. Hyphae of pileipellis, with clamp connections. 5, 6. Basidia and basidiospores. 7, 8. Cheilocystidia. 9. Basidiospore. 10. Detail of hilar appendage. 11. Tetrasporic basidia and basidiospores.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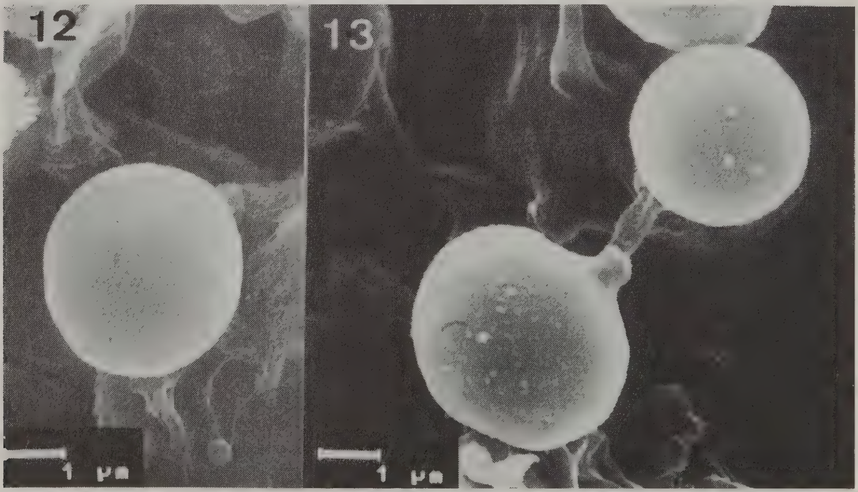
Basidiomes very small, omphalinoid, pileus up to 2-10 mm in diam., greyish, with bluish-grey tinges when dry, fibrillose, convex to umbilicate at maturity, with incurved margin. Lamellae greyish, decurrent, well developed (up to 26 in one specimen), sometimes forked, strongly anastomosing in mature basidiomes, lamellulae occasionally present. Stipe 4-7 x 1 mm, cylindrical, fully developed, central to eccentric, greyish, whitish towards the base. Odour and taste not distinctive.

Basidiospores 3.5-5 x 3.5 4.5 µm, globose to subglobose, hyaline, containing lipidic guttules, neither amyloid nor dextrinoid. Basidia 24-28 x 5-6 µm, clavate, tetrasporic, more rarely mono- or bisporic. Pleurocystidia absent. Cheilocystidia (cystidia-like hyphal ends) scarce, filiform, sometimes ramified towards the apex. Pileipellis a cutis, consisting of cylindrical hyphae up to 4-7 µm diam., with a grey yellowish pigment encrusting the walls of hyphae. Cortical layers not embedded in gelatinous matter. Clamp connections present in all tissues.

Observations: *Omphalina subglobispora* sp. nov., is characterized by its greyish very small basidiomata, its decurrent greyish lamellae, its globose small basidiospores and its muscicolous habitat (parasitic of living gametophytes of mosses).

Globose to subglobose basidiospores is a character rarely observed in species of the genus *Omphalina*. One of those is *O. cyathella* Favre & Schweers (FAVRE & SCHWEERS, 1942), which differs, however, from *O. subglobispora* both by its larger basidiospores and by its habitat (on decaying culms of *Carex*).



Figs. 12-13.- *Omphalina subglobispora* G. Moreno, Heykoop & E. Horak: AH 19710, (holotype). 12, 13. Basidiospores.

Because of the very small size and the muscicolous habitat of *Omphalina subglobispora* we thought at first to deal with a species of *Arrhenia*. But a more detailed examination revealed, however, that on account of its distinctive, central stipe and the strongly decurrent and well developed lamellae, this taxon rather belongs to *Omphalina*. As pointed out by REDHEAD (1984), there are actually close links between the bryophilous species of *Omphalina* and *Arrhenia*. Following SINGER's (1986) generic delimitations the presence of anastomosing, vein-like lamellae and the presence of an eccentric stipe are typical characters for *Arrhenia*. Thus, the taxonomic position of the present species is apparently intermediate between *Omphalina* and *Arrhenia*. However, the spore shape rather points towards close relationships to several taxa of *Omphalina* with globose to subglobose basidiospores. Our proposal to transfer the present taxon to *Omphalina* is further supported by SINGER (1970) who emphasizes that species of typical *Leptoglossum* [considered by REDHEAD (1984) as a synonym of *Arrhenia*] never have globose basidiospores.

According to our literature search, all bryophilous species of *Omphalina* viz. *O. olivaria* (Peck) Singer, *O. occidentalis* (A.H. Smith) Bigelow, *O. sphagnophila* (Peck) Bigelow or *O. oniscus* (Fr.: Fr.) Quél., have basidiospoes of different shape and size and hence are not contaxic with *O. subglobispora*.

Agaricus fuscifrons –a name applied to our new taxon by some authors- was originally described by BERKELEY & CURTIS (1868) from Cuba. Subsequently, this taxon has been misinterpreted by several authors which led to nomenclatural problems. LANGE (1935) illustrated "*Pleurotus fuscifrons*" on plate 65B of Flora Agaricina Danica. The description and the illustration clearly relate to an omphalinoid agaric with subglobose, hyaline and smooth basidiospores. These features undoubtedly correspond to *Omphalina subglobispora* as conceived by the authors of the present contribution. Later, MOSER (1978) accepted LANGE's interpretation (citation of basionym and plate number are wrong!, comb. inval.) and transferred this taxon to *Leptoglossum* viz. *L. fuscifrons* (Fr.). Finally, PEGLER (1987) discovered that the type material of *Agaricus fuscifrons* Berk. & M.A. Curtis (kept in Herbarium Kew, K) is characterized by the following features: "The laterally stipitate basidiomes bear basidiospores, 5-6 x 4-4.5 µm, subglobose to ovoid, with a suprahilar depression, ferruginous, and coarsely verrucose. The lamella-edge has subcapitate cheilocystidia. The material is typical of *Pyrrhoglossum pyrrhum* (Berk. & M.A. Curtis) Singer". Hence, we conclude that the Cuban type collection is actually identical with *Pyrrhoglossum pyrrhum* and consequently LANGE (1935) and MOSER (1978) have misinterpreted this taxon. Under these circumstances, the new species "*Omphalina subglobispora*" is proposed for the European material of "*Pleurotus fuscifrons*".

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LUNDQUISTIA, A NEW GENUS OF USTILAGINOMYCETES

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Key words: *Lundquistia fascicularis*, new species, smut fungi.

ABSTRACT

A new genus of Ustilaginomycetes, *Lundquistia*, is proposed, with its type *Lundquistia fascicularis*, sp. nov., on *Digitaria brownii* from Australia.

Study of Australian Ustilaginomycetes revealed that an unidentified collection represents a new species which cannot be classified in earlier known genera (comp. Vánky, 1987, and later published genera). For it a new genus is proposed:

Lundquistia Vánky, gen. nov.

Sori in partibus distinctis (foliis, caulibus, inflorescentiis) plantarum nutrientium familiae Gramineae, cum glomerulis sporarum in telis plantae nutrientis immissis. Peridium nullum, columella nulla, cellulae steriles nullae. Sporae pigmentose brunneae (non aurantiaco-flavidae). Glomeruli sporarum in massa hypharum sporogenarum evolventes, sine hyphis concentricis circumdantibus. Hyphae parasiticae intracellulares. Typus generis: *Lundquistia fascicularis*.

Sori in different parts (leaves, stems, inflorescence) of the host plants belonging to Gramineae, with spore balls embedded in the host tissues. No peridium, no columella, no sterile cells. Spores pigmented brown (not orange-yellow). Spore balls differentiate within the mass of sporogenous hyphae, without concentric hyphae around them. Parasitic hyphae intracellular. Type:

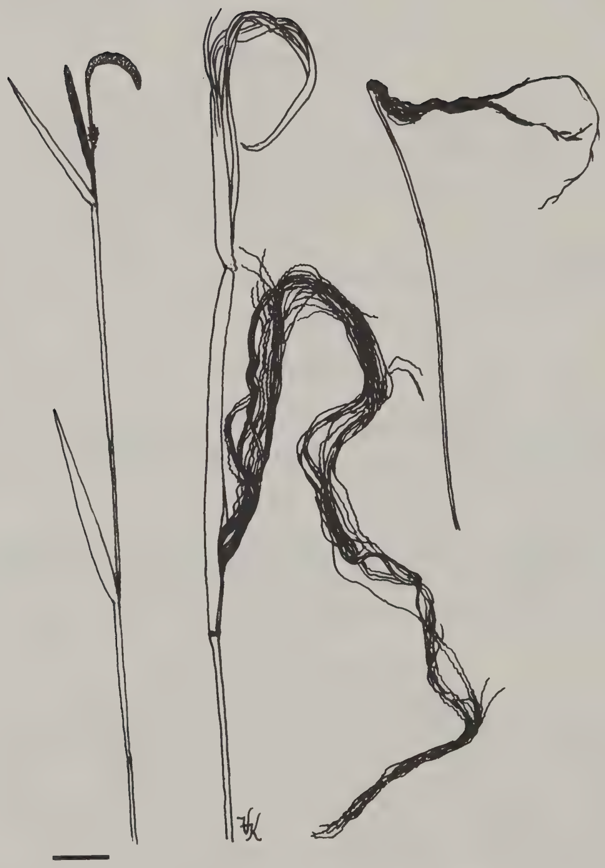


Fig. 1. Sori of *Lundquistia fascicularis* Vánky in the inflorescence (to the left), in the uppermost leaves (in the middle), and in the floral stem (to the right) of *Digitaria brownii* (Roem. & Schult.) Hughes (type). Bar = 1 cm.

Lundquistia fascicularis Vánky, **sp. nov.**

Typus in matrice *Digitaria brownii* (Roem. & Schult.) Hughes, Australia, New South Wales, NW pag. Hermidale, inter oppid. Cobar et Nyngan, 1.III.1971, leg. D. A. Campbell. Holotypus in DAR 58832!, isotypus in Herbario Ustil. Vánky, HUV 19444!

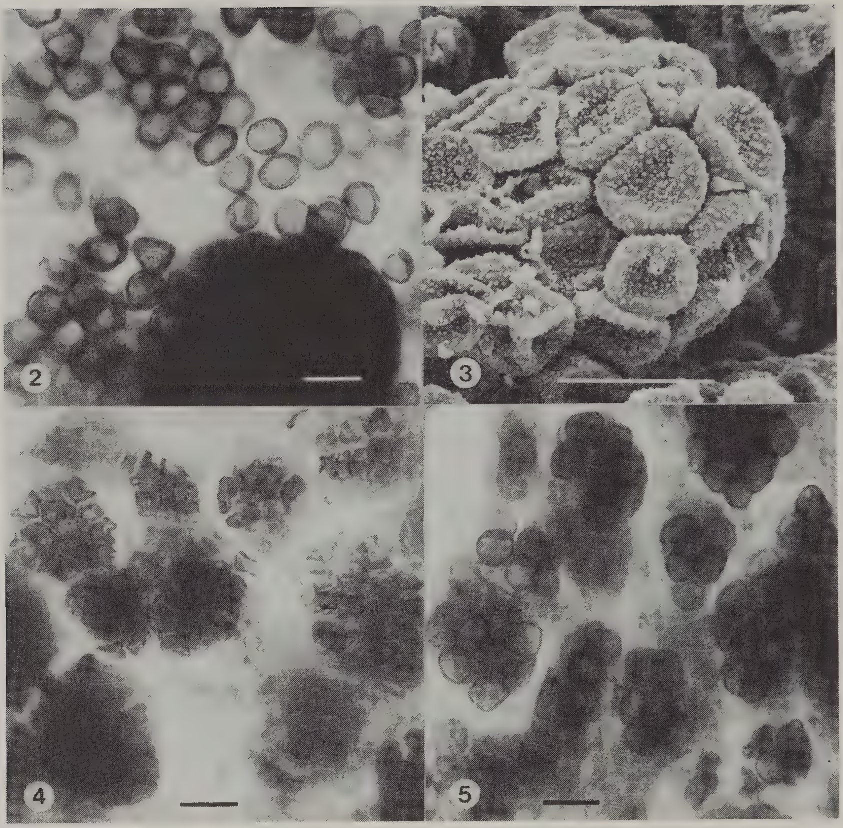
Sori (Fig. 1) in foliis supremis, caulibus, inflorescentia vel in parte eorum, cum glomerulis sporarum in telis parenchymaticis immissis. Telae destructae longitudinaliter ruptae et massa glomerulorum sporarum atrobrunnea, semiagglutinata usque pulverea dispersa, fasciculos fascium vasorum relinquentes. Peridium nullum, columella nulla. *Glomeruli sporarum* (Figg. 2, 3) globosi, ellipsoidales, elongati vel parum irregulares, 20–50 x 25–70 μm, flavido- usque atro-brunnei, e sporis 15–100 (vel plus?) pressu separabilibus compositi. Glomeruli sporarum in massa hypharum sporogenarum evolventes, sine hyphis concentricis eos circumdantibus (Figg. 4, 5). *Sporae* (Figg. 2, 3) subglobosae, ovoideae, ellipsoidales usque subpolyedriciter irregulares, 5,5–8 x 6,5–9,5(–10.5) μm, flavidobrunneae; pariete aequaliter crasso, cca. 0,5 μm, mediocriter dense verrucoso, imago oblique sporarum levis, usque modo leviter undulata. *Cellulae steriles* nullae.

Sori (Fig. 1) in uppermost leaves, stems, inflorescence, or part of them, with spore balls embedded in the parenchymatous tissues. Destroyed tissues rupture longitudinally and the dark brown, semiagglutinated to powdery mass of spore balls is scattered leaving behind fascicles of vascular bands. No peridium, no columella. *Spore balls* (Figs. 2, 3) globose, ellipsoidal, elongate or slightly irregular, 20–50 x 25–70 μm, yellowish- to dark brown, composed of 15–100 or more? spores which separate by pressure. Spore balls differentiate within the mass of sporogenous hyphae, without concentric hyphae around them (Figs. 4, 5). *Spores* (Figs. 2, 3) subglobose, ovoid, ellipsoidal to subpolyhedrally irregular, 5.5–8 x 6.5–9.5(–10.5) μm, yellowish-brown; wall evenly thick, c. 0.5 μm, moderately densely verrucose, spore profile smooth to just finely wavy. *Sterile cells* absent.

On Gramineae *Digitaria brownii* (Roem. & Schult.) Hughes. Known only from the type collection.

Etymology: *Lundquistia* is named after the outstanding Swedish mycologist, Prof. emeritus Nils Lundqvist, a helpful and unselfish human person and friend, at the occasion of his 70th birthday.

Lundquistia differs from *Ustilago* in the presence of spore balls, from *Sporisorium* in the structure of the sori, absence of peridium, columella and sterile cells, and in the mode of spore ball building. It differs also from *Macalpinomyces* in having spore balls and lacking sterile cells, and from *Fulvisporium* in the intracellular hyphae and brown colour of the spores. In *Fulvisporium*, belonging to the Urediniomycetes, the parasitic hyphae are intercellular, and the spores are golden-yellow.



Figs. 2–5. *Lundquistia fascicularis* Vánky on *Digitaria brownii* (Roem. & Schult.) Hughes (type). Bars = 10 µm.
Figs. 2, 3. Mature spores and spore balls.
Figs. 4, 5. Young spore balls in different developmental stages.

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REDESCRIPTION OF PHYTOPHTHORA POLYGONI

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ABSTRACT

Following the recent rediscovery of *Phytophthora polygoni* Saw. in Jiangsu Province of China and the induction of sexual structures in the leaves of *Rumex dentatus* L., a full description of the species is provided.

Keywords: *Phytophthora polygoni; Rumex dentatus;* China

Phytophthora polygoni was first discovered and described on the leaves of *Polygonum japonicum* Meisn. (Family Polygonaceae) in Taipei and Taichung of Taiwan causing a leaf spot disease from the late winter/early spring to early summer but could not be isolated on media (Sawada, 1922). The species was distinguished from other *Phytophthora* species which could not be cultured, primarily by the small, narrowly elongated to fusiform sporangia. Waterhouse (1963) excluded *P. polygoni* from her key to *Phytophthora* because of the lack of a description of sex organs. Ho and Chang (1992) re-examined the taxonomic status of all 23 species of *Phytophthora* described by Sawada but since no type specimens could be located they tentatively accepted the judgment of Waterhouse (1963).

Recently, Zheng and Ho (1998) rediscovered *Phytophthora polygoni* on the leaves of *Rumex dentatus* (Family Polygonaceae) in Jiangsu Province of China with pathological and morphological characteristics similar to those described by Sawada (1922). Subsequently, they were able to induce the formation of sex organs in diseased leaves from the field or by artificial inoculation of healthy symptomless leaves (Zheng and Ho, 2000). Consequently, *P. polygoni* should now be accepted as a valid species within the genus *Phytophthora.* Since Sawada's type specimen is no longer in existence, a redescription of the species is hereby provided based on the elucidation of the complete life cycle.

Phytophthora polygoni Sawada ex Zheng & Ho

= *Phytophthora polygoni* Saw., Rept. Dept. Agr. Gov. Res. Inst. Formosa 2:32. 1922.

= *Kawakamia polygoni* (Saw.) Saw., Formosan Agr. Res. 38:351. 1942.

Maculae in foliis rotundulae vel irregulares, diffuse marginatae, primo obscure rosidulo-brunneae deinde rubro-nigrescentes; hyphae intercellulares 8-12 µm latae, incolores, aseptatae, libere ramificantes, inter cellulas intra laesiones in cellulas hospitis haustora ovalia emittentes. Sporangia pusilla, ellipsoidalia vel elongato-ellipsoidalia, fusiformia vel obpyriformia, basem versus angustata atque saepe rostro subelongato praedita, (18.9-)37.1(-28.8) x (11.3-)17.7(-23.8) µm, ratione arithmetica longitudinis usque latitudinis (18.6)2.1(-2.8), semipapillata, in apice non profunde incrassata, (0.5-)1.7(-2.7) µm crassa, singularia, terminalia in sporangiophoris simplicibus vel interdum sympodialiter ramificantibus (1.8-)2.2(-2.5) µm latis, e stomatibus in fasciculos e 10-30 individuis compositos emergentibus; sporangia matura decidua septo basali atque pedicello medio, 20-45 µm longo. Zoosporae biflagellatae primo intra sporangium formantes deinde per apicem sporangialem e poro exitus (5.0-)6.4(-7.5) µm lato depulsae. Ooogonia laevia, globosa, tenuitunicata (28.5-)33(-42)µm; oospora singularis, laevis, globosa, aperotica vel valde aplerotica (24.7-)28.1(-32.3) µm diam., pariete 3-4 µm crasso praedita; antheridium paragyna 13-25 x 10-15 µm, ad laterem vel apicem oogonii affixum.. Corpora chlamydosporoidea, globosa (12.3-)16(-24.6) µm diam. atque (24.6-)31(-36.9) µm diam. Cultura ignota.

In foliis *Rumex dentatus* L. habitat.

Spots on leaves of *Rumex dentatus* L. caused by *Phytophthora polygoni* are roundish to irregular with diffuse edges, blurry pinkish brown changing to reddish black; hyphae are intercellular 8-12 µm wide, colorless, aseptate, branching freely between host cells within the lesions; oval haustoria penetrate host cells. Sporangia are small, ellipsoidal to elongate ellipsoidal, fusiform or obpyriform with tapered base and often have a slightly elongated beak, (18.9-) 37.1 (-28.8) x (11.3-) 17.7 (-23.8) µm, have a length/breadth ratio of (1.86-) 2.1 (-2.8), are semi-papillate with shallow apical thickening (0.5-) 1.7 (-2.7) µm deep; are single and terminal on unbranched or occasionally sympodially branched sporangiophores (1.8-) 2.2 (-2.5) µm wide, emerging from host stoma in clusters of 10-30; mature sporangia are deciduous with medium length pedicels, 20-45 µm long with a basal septum. Biflagellate zoospores are formed within the sporangium and expelled through the sporangial apex via an exit pore (5.0-) 6.4 (-7.5) µm wide. Oogonia are globose and smooth, thin-walled, (28.5-) 33 (-42) µm diam; oospores are single in the oogonium, smooth, globose, aplerotic to markedly aplerotic, (24.7-) 28.1 (-32.3) µm diam with walls 3-4 µm thick; antheridia are paragynous, 13-25 x 10-15 µm, attached laterally or apically to the oogonium. Chlamydospore-like bodies are globose, and consist of small (12.3-) 16 (-24.6) µm diam and large (24,6-) 31 (-36.9) µm diam sizes. Could not be cultured.

Hab. in leaves of *Rumex dentatus* L.

HOLOTYPE. CHINA. JIANGSU: Nanjing (NJ-9801). 6 April 1997. ISOTYPE. Yangzhou (YZ-9802), 2 June 1998. Induced sexual structures of the holotype and isotype are preserved in lactophenol in sealed tubes and on microscope slides. Types are deposited at Plant Pathogen Research Institute, Nanjing Agriculural University.

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SECONDARY METABOLITE PROFILES, GENETIC FINGERPRINTS AND TAXONOMY OF DALDINIA AND ALLIES

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ABSTRACT

Daldinia and allied Xylariaceae from around the world were studied for (i) morphology of teleomorphs and anamorphs, (ii) metabolite patterns in stromata and cultures employing HPLC-UV-Vis and HPLC-ESI-MS; and (iii) PCR- amplified 18S rDNA restriction patterns (ARDRA). Comparing type materials, herbarium specimens, cultures, and freshly collected materials revealed additional evidence on their geographic distribution. Stromata of a given species never contained the same major metabolites as corresponding cultures. Most cultures of *Daldinia* spp. produced naphthalene and chromone derivatives, differing from allied genera by the absence of mellein. Stromata of *Daldinia* spp. generally contained binaphthyls but no mitorubrin. HPLC profiles were in accordance with colours of KOH-extractable stromatal pigments. While *D. childiae* contained azaphilones and benzophenones, species with purple pigments are lacking those. Cytochalasins were found in *D. eschscholzii*. ARDRA resolved several species whose 18S rDNA contained specific insertions.

Key words: Chemotaxonomy, HPLC, PCR, 18S rDNA, Xylariaceae

INTRODUCTION

Presently, the genus *Daldinia* Ces. & De Not. 1863 comprises 21 species of angiosperm-associated ascomycetes, whose rather conspicuous stromata are distinguished macroscopically from other Xylariaceae by the presence of internal alternating light- and dark-coloured rings. The type of the genus is *D. concentrica* (Bolton: Fr.) Ces. & De Not., which was firstly described by Bolton (1789) in Great Britain. Lloyd (1919) and Child (1932) were among the first to study the biology of *Daldinia* and give evidence on the existence of several species within the genus. Teleomorphs and corresponding anamorphs of some European *Daldinia* spp. were described by Petrini and Müller (1986). Tropical species of the genus were studied as well, and surveys of *Daldinia* are now available from countries such as Papua New Guinea (Van der Gucht, 1994 and 1995) and Mexico (San Martín, 1992). In the monograph by Ju et al. (1997), a new key was established. The authors described several new species, employing stromatal pigment colours in 10% KOH (i.e., a character relating to secondary metabolites) as a taxonomic criterion for the first time.

Bolton` s holotype material had been lost to Science for a long time and was recovered only recently, which resulted in a re-typification by Rogers et al. (1999). Aided by comparison of KOH-extractable pigments, it was established that *D. concentrica* ss. Rogers et al. (1999) is common on *Fraxinus* in Europe, while a new species (*D. childiae*) was erected for the cosmopolitan taxon which had previously been regarded as *D. concentrica* by most investigators. Recently, Ju et al. (1999) described *D. singularis* from Russia, included further anamorphic descriptions and suggested the existence of further *Daldinia* spp. in Europe and Asia.

For an extensive description of teleomorphic characters, biology and ecology of *Daldinia*, the reader is referred to the monograph by Ju et al. (1997). The shape and size of their ascospores in correlation to fruitbody morphology are helpful diagnostic characters to discriminate the speices within this genus. The anamorphic states of *Daldinia* spp. and allies are morphologically rather similar, ranging from *Nodulisporium*-like to *Sporothrix* and *Virgariella*-like and further branching patterns (see definition by Ju and Rogers, 1996). These characters were shown to be of great relevance for discrimination of these fungi on the species level. In addition to having different branching types, cultures of some species such as *D. petriniae* are characterised by producing conidia from percurrently proliferating cells, which become annellated, while most *Daldinia* spp. produce conidia from conidiogenous cells that proliferate in a sympodial manner (Ju et al., 1997).

Despite the above mentioned criteria (stromatal morphology, ascospore shape and size, conidial state and colour of stromatal pigments) proving quite valuable, *Daldinia* spp. generally are not easy to determine. Various questions regarding the taxonomy of this genus and its affinities remain to be answered. This gave impetus to use a significant number of specimens and cultures to study the feasibility of alternative identification techniques.

Ju et al. (1997) stated that "*essentially nothing is known about the genetics of Daldinia species*". Although *D. concentrica* and *Xylaria hypoxylon* were included in a comparative study on 18S rDNA sequences of various representative ascomycetes (Spatafora and Blackwell, 1993), techniques related to molecular genetics were not yet frequently employed to study Xylariaceae. Only recently, Johannesson et al. (2000) provided evidence on the usefulness of DNA sequencing data of the ITS region for intrageneric discrimination of *Daldinia.* These authors also described the occurrence of several *Daldinia* spp. in Northern Europe and the U.K. and provided evidence on the circumpolar distribution of *D. loculata*.

Xylariaceaous fungi are extremely creative with regard to the production of secondary metabolites (Dreyfus and Chapela, 1994). Numerous structurally unique compounds with interesting biological activities are continuously being obtained from these fungi (e.g., Meinke et al., 1998, Schlingmann et al., 1998, Lingham et al., 1999, Schneider et al., 1995), while other metabolites were proven to be of taxonomic significance (Whalley and Edwards, 1995). In contrast to *Hypoxylon* and other genera, the secondary metabolism of *Daldinia* has not yet been studied intensively on the species level. Ju et al. (1997) stated that "*the typical stromatal pigments of Hypoxylon, mitorubrin or related compounds are probably to be found in Daldinia*". In fact, mitorubrin had so far only been isolated to purity from *H. fragiforme* (Steglich et al., 1974), and detected tentatively by thin layer chromatography in other *Hypoxylon* spp. (Whalley and Whalley, 1977). In contrast, Hashimoto and Asakawa (1998, and refs. therein) reported different metabolites from stromata of *Daldinia* spp. occurring in Japan. Moreover, virtually nothing is known on correlations between the occurrence of particular metabolites in stromata and resulting mycelial cultures of these fungi. The usefulness of modern chromatographic methods has in the past been proven for the detection of a broad range of fungal metabolites of various chemical types (Frisvad and Thrane, 1987), and the importance of secondary metabolites in fungal taxonomy was demonstrated in Xylariaceae and other ascomyceteous fungi (Whalley and Edwards, 1995; recent summary by Frisvad et al., 1998).

In the following, we attempt to add information on correlations between morphology and secondary metabolism (inspired by Whalley and Edwards, 1995) in stromata and cultures of *Daldinia* spp. and allies, employing high performance liquid chromatography (**HPLC**). We also include a preliminary characterisation of their genetic affinities as established by PCR-based restriction analysis of the amplified nuclear small subunit rDNA (**ARDRA**). The aim of these studies was to improve the future identification of *Daldinia* spp.

and, possibly, to provide a basis for the polyphasic classification of these fungi Preliminary results were reported previously (Stadler et al., 1998a; Stadler et al., 2000).

EXPERIMENTAL

SOLVENTS AND CHEMICALS: If not stated otherwise, culture media ingredients and solvents for chromatography and spectroscopy were obtained from Merck (Darmstadt, Germany), while all solid chemicals were provided by Sigma-Aldrich (Deisenhofen, Germany).

BIOLOGICAL MATERIALS: The taxonomy of *Daldinia* spp. is given according to Rogers et al. (1999), while the species of allied genera were determined by the keys provided by Ju et al. (1998) and Ju and Rogers (1996). Comprehensive coverage of the current taxonomy of most xylariaceous genera is also being provided on the Internet "Xylariaceae homepage" (see ***http://mycology wsu.edu/xylariaceae***).

Information on the origin of all examined specimens and cultures is summarised in Tabs. 1 - 3. If not indicated otherwise, voucher specimens were deposited at the herbarium of the Fuhlrott-Museum (H.W., Wuppertal, Germany). Reference materials were either collected by the authors or kindly provided by the individuals and institutions as stated in these Tabs.. For better overview, all collections were assigned a **Ww number**, no matter from which location they were originally derived, and are referred to this number in the following narrative. Corresponding cultures bear the same Ww number as the stromatal starting materials. New cultures were isolated using YMG agar (D-glucose 4 g; malt extract 1 g; yeast extract 4 g; agar-agar 15 g ad 1 l tap water, pH adjustment to 6.3 prior to autoclaving at 121°C; containing 50 mg/l penicillin G and 75 mg/l streptomycin sulphate as supplement) from ascospores or conidia, following a similar procedure as reported by Ju et al. (1997). Reference strains were obtained from: Centraalbureau voor Schimmelcultures, Baarn, The Netherlands (**CBS**); American Type Culture Collection, Rockville, Md, USA (**ATCC**); International Mycological Institute, Egham, Surrey, U.K. (**IMI**); Deutsche Sammlung von Mikroorganismen und Zellkulturen, Braunschweig, Germany (**DSM**); and Mycothéque de l´ Université catholique de Louvain, Louvain-la Neuve, Belgium (**MUCL**). Further reference strains, whose ITS sequence data and further characteristics had been reported previously (Johannesson et al., 2000), were kindly provided by H. Johannesson, Uppsala, Sweden.

MAINTENANCE, FERMENTATION AND EXTRACTION OF CULTURES: Cultures are maintained under liquid nitrogen in 10% glycerol at the Bayer Pharma Research Center (Wuppertal, Germany). For morphological studies and ARDRA, the strains were grown on YMG agar without antibiotics and on Difco Oatmeal agar, following the method described by Ju et al. (1997). For their fermentation, submerged cultures were prepared by adding 2 ml of a 10% glycerol culture to 500 ml Erlenmeyer flasks containing 150 ml of YMG medium without agar-agar and antibiotics. The cultures were propagated in the dark on a rotary shaker at 140 rpm. Free glucose in the culture media was estimated using "Diastix Harnzuckerstreifen" (Bayer Diagnostics, Munich, Germany). All cultures were harvested after ten or eleven days, when the glucose was depleted, indicating the onset of the stationary growth phase and, thus, the biosynthesis of secondary metabolites (see also Stadler, 1993, for a similar fermentation of a *Daldinia* sp.). Immediately after harvest, the cultures were freeze-dried, and the resulting materials were stored at 4°C until further use. Crude materials were extracted with methanol (**MeOH**) at concentrations of 0.5 mg/ml for 30 min in an ultrasonic bath. The extracts were subjected to centrifugation (10 min at 1000 x g), and the supernatants were evaporated to dryness at 30°C and a pressure of 1 mbar using a Christ (Osterode, Germany) Alpha AVC Speedvac. The remaining oily residues were dissolved in MeOH at concentrations of 5 mg/ml and clarified by their filtering through a FGS sterile filter (Millipore, Eschborn, Germany). Aliquots of these MeOH solutions were subjected to analytical HPLC with UV-visual **(HPLC-UV-Vis)** and mass spectrometric (**HPLC-MS**) detection as described below.

EXTRACTION OF STROMATA: Prior to extraction, the stromatal materials were examined microscopically to exclude contaminants, and small specimens were detached carefully from their substrates under a dissecting microscope. Aliquots of the fresh, dried or freeze-dried stromata, always containing materials from the pigmented ectostroma, were ground in a mortar. MeOH extracts were prepared from these powdery materials (minimum amounts used for extraction were 10 mg) as described above for fermentation-derived materials. Some extracts were also prepared from materials of the ectostroma with 10% KOH according to Ju et al. (1997), always followed by HPLC analyses immediately after extraction and filtration.

HPLC-MS analyses were performed using a TSP liquid chromatograph directly coupled with a MAT 900S mass spectrometer (Finnigan, Bremen, Germany) in the positive electrospray ionisation (**ESI**) mode, using a Waters Symmetry column as stationary phase and a previously described method (Stadler et al., 1998b). Mass spectra were recorded in the range of molecular weights between 150 and 1.200. HPLC-UV analyses were carried out on a Hewlett Packard Series 1100 analytical HPLC system (HP, Waldbronn, Germany) comprising a G 1312A binary pump system, a G 1315A diode array detector, a G 1316A column compartment, a G 1322A degaser and a G 1313A autoinjector. As mobile phase, 0.1% H_3PO_4: Acetonitrile (**ACN**) was chosen, while a Merck (Darmstadt, Germany) Lichrospher RP 18 column (125 x 4 mm, particle size 5 µm) was employed as stationary phase. Aliquots of the samples (representing 2 – 10 µg of methanol-soluble materials, according to the concentration of main metabolites) were analysed at 40°C with a flow of 1 ml/min in the following gradient: Linear from 0% ACN to 100% ACN in 10 min, thereafter isocratic conditions at 100% ACN for 5 min; followed by regeneration of the column for five min. For separation of BNT (**1**) from the yet unknown metabolite (**12a**) in stromatal extracts of *D. petriniae*, this gradient (corresponding to chromatogram B in Fig. 7) was modified as follows: 0 – 70% ACN in 8 min, thereafter isocratic conditions at 80% ACN for 3 min, followed by elution from 80% to 100% ACN in 5 min, thereafter regeneration of the column. HPLC-UV chromatograms were recorded at 210 nm with a reference wavelength of 550 nm and a bandwidth of 80 nm. Diode array detection (**DAD**) was employed to record HPLC-UV/Vis spectra in the range of 210 –

600 nm. For data storage and analysis the HP ChemStation software was employed, which provided data as exemplified by the chromatograms and spectra depicted in the Results section. This software even allowed for an automated search for calibrated standard compounds or ones with similar UV-visual spectra in the crude extracts. Out of more than 100 metabolites detected by these techniques, fifteen have so far been identified and chosen as standards, while the remaining data were saved in a HPLC library file to support further investigations. The chemical structures of these metabolites are depicted in Fig. 1, while their characteristic UV-visual spectra are compiled in Fig. 2. Their retention times (**Rt**) and characteristic ESI-LC-MS signals are summarised in Tab. 4.

PREPARATIVE HPLC: In order to obtain standards of BNT (**1**) and mitorubrin derivatives (**2** - **4**), extracts of several species were subjected to preparative HPLC. For this purpose, 100 mg of crude MeOH extracts were dissolved in 2 ml of MeOH. This suspension was filtered through a Bond Elut C18 500 mg solid phase extraction cartridge (Baker, Deventer, The Netherlands) and applied directly onto a Merck (Darmstadt, Germany) LichroSorb RP18 column (particle size, 7 µm; column dimension, 250 x 25 mm; mobile phase, 0.01% trifluoroacetic acid : ACN). The experiments were performed at room temperature on a preparative HPLC system (Gilson Abimed, Ratingen, Germany), comprising Gilson Unipoint software, 306 binary pump system, 205 fraction collector, 119 UV-Vis detector, 806 manometric module, and 811C dynamic mixer. The following experimental conditions were employed: Linear gradient: 20% to 100% ACN in 60 min; thereafter isocratic conditions at 100% ACN for 30 min at a flow of 9 ml/min. Aliquots of each 9 ml were fractionated and combined according to UV adsorption at 210 nm. Retention times (Rt) in this gradient system were observed as follows: 56 - 58 min for BNT (**1**), 40 - 41 min for mitorubrin (**2**), 20 - 21 min for mitorubrinol (**3**) and 49-51 min for mitorubrinol acetate (**4**). 100 mg of crude MeOH extract from *H. fuscum* Ww 3331 yielded 2 mg of (**2**), 2 mg of (**3**) and 6 mg of (**4**), whereas 100 mg crude MeOH extract from stromata of *H. howeianum* STMA 9609 afforded 3 mg of (**2**), 4 mg of (**3**) and 8 mg of (**4**). BNT (**1**) was obtained from stromatal extracts of *H. macrocarpum* Ww 3243 (4 mg from 100 mg MeOH extract) and *D. concentrica* Ww 3316 (7 mg from 100 mg MeOH extract) by preparative HPLC in the same system.

STRUCTURE ELUCIDATION: Compounds **1** - **4** were identified by comparison of their spectral data with those reported in the literature (Allport and Bu´Lock, 1958; Steglich et al., 1974; Hashimoto et al., 1994). Nuclear magnetic resonance (**NMR**) spectra were recorded on a Bruker DRX 400 spectrograph (400 MHz), whereas mass spectrometry (**MS**) was conducted using a ThermoQuest Finnigan MAT 90 spectrometer. The characteristic metabolites from *Daldinia* cultures (**9** and **10**), as well as mellein type metabolites (**11**) were identified by repetition of previously described HPLC-UV and HPLC-MS analyses. Their characteristic UV spectra and retention times in standardised HPLC gradients using the same analytical HPLC columns had been reported previously in the course of their isolation from *Xylaria* (Schneider, 1996) and *Daldinia* spp. (Stadler, 1993), respectively. Cytochalasins, benzophenones and azaphilones (**5** - **8**) from stromata of *Daldinia* spp. were isolated as described previously (Hashimoto and Asakawa, 1998, and references therein). The identity of all compounds was established based on their Rt, characteristic UV-Vis spectra and positive ESI mass spectra.

DNA EXTRACTION: Suitable DNA for the amplification of ribosomal DNA was obtained from mycelia grown in solid and liquid cultures as well as from freshly collected specimens. With freeze-dried or air-dried stromata, the quality of the isolated DNA (as judged from the size distribution of isolated fragments) decreased with the age of the starting material. Prior to DNA extraction, small aliquots of mycelia or stromatal materials were washed and resuspended in 96% ethanol and transferred to Eppendorf tubes (Eppendorf, Hamburg, Germany). The materials were pressed against the wall of the tubes, and the solvent was removed with a pipette. After air-drying of the samples, small amounts of sea sand (Merck, Darmstadt, Germany) and 200 µl of extraction buffer (2 M NaCl, 20 mM EDTA, 10 mM Tris-HCl, 2% (w/v) N-acetyl-N,N,N-trimethyl ammonium bromide, 2% polyvinyl pyrrolidone; pH 8.0 (modified according to Tinker et al., 1993) were added, and the mycelia were disrupted using micropestles fitting in 1.5 ml reaction tubes (Eppendorf, Hamburg, Germany). The resulting lysate was extracted with chloroform. After centrifugation, the supernatant was mixed with an equal volume of 2-propanol to precipitate the nucleic acids. The sediment obtained after centrifugation was washed in 70% ethanol and dissolved in 200 µl of sterile water. 1 µl of this preparation was used as template for PCR amplifications, while the remainder was maintained at -20 °C until further use.

AMPLIFICATION OF 18 S rDNA: A segment comprising approximately 1.1 kb of the nuclear small subunit (18S) rRNA gene was amplified using the fluorescently labelled primer NS1 (Bowman, 1993) and primer RDR116 (White et al., 1990). The polymerase chain reaction (**PCR**) was performed in reaction volumes of 25 µl containing 5pmol of each primer, 1 U of *Taq* polymerase (Amersham Pharmacia, Freiburg, Germany) 1 x reaction buffer (10 mM Tris-HCl pH 9) at room temperature, 1.5 mM $MgCl_2$, and 50 mM KCl), 200 µM of each of the four deoxy nucleotides, 0.1% bovine serum albumin (BSA) and 1 µl of the DNA preparation. The initial denaturation for 120 s at 94°C was followed by 35 to 40 cycles (40 s at 94°C; 60 s at 50°C; 120 s at 72°C), closing with a final extension (180 s at 72°C).

RESTRICTION ANALYSIS OF THE AMPLIFIED NUCLEAR SMALL SUBUNIT rDNA (**ARDRA**): The amplification products were partially restricted using the restriction enzymes *Hpa*II, *Hae*III or *Taq* I. The restriction product mixes were applied onto an acrylamide gel and separated using an automated laser fluorescent (**A.L.F.**) sequencer (Pharmacia Biotech, Freiburg, Germany). Detailed descriptions of the procedure were given in Tötsch et al. (1995). The data files generated by the A.L.F. Manager software were processed using GelCompar (Applied Maths, Kortrijk, Belgium) image analysis software, facilitating comparison and grouping of patterns. All three patterns obtained for each individual isolate by application of the three restriction enzymes were combined into single profiles. These profiles were compared by means of the algorithm of Dice and grouped according to the unweighted pair group method using arithmetic averages (UPGMA).

Table 1. List of examined *Daldinia* spp., including designation numbers, origin, collectors and identifiers, hosts and colour of pigment in 10% KOH. If not indicated otherwise, all specimens were mature and were collected and identified by H.W. & M.S.

Species/No	Collection site/time	Substrate	Comments/References	KOH reaction
***D. bambusicola* Ju et al. (1997)**				
Ww 3707	Nakorn Nayok, THAILAND, X. 1994	*Bambusa* sp.	WSP 69652, HOLOTYPE (Ju et al., 1997)	purple +
***D. caldariorum* Henn.**				
Ww 3692	Cornwall, Padstow, U.K., IV. 1993	*Ulex*	K (M) 47.140, leg. et det. M. C. Clark	purple +
Ww 3292	Barra, SPAIN, IX. 1992	*Cytisus*	F. Candoussau; 5365-595 (Ju et al., 1997)	purple +++
***D. childiae* Rogers et al. (1999)**				
Ww 3293	Barthe, Landes, FRANCE, IX. 1985	*Alnus glutinosa*	ETH, leg. G. Gilles, Petrini and Müller (1986) as *D. eschscholzii cf.*	yellow +++
Ww 3295	Oloron-Ste. Marie, FRANCE, X. 1981	*Fraxinus*	ETH, Petrini and Müller (1986) as *D. eschscholzii cf.*	yellow +++
Ww 3296	Nay, FRANCE, X. 1991	*Fraxinus*	ETH, Petrini and Müller (1986) as *D. eschscholzii cf.*	yellow +++
Ww 3388	Mantenia, Bucarest, ROMANIA, V. 1933	*Acer campestris*	M, leg. Savulescu; immature specimens	yellow ++
Ww 3550	Tokushima, JAPAN, I. 1993	wood	Hashimoto et al., 1994	yellow ++
Ww 3587	Itxassou, FRANCE, VI. 1999	*Fraxinus*	aged specimens	yellow +++
Ww 3597	Kamiyama-cho, Shikoku, JAPAN, VI. 1999	wood	immature specimens	yelow +++
Ww 3603	Rekawinkel, Vienna, AUSTRIA, VII 1940	*Carpinus*	M; immature specimens, leg. F. Petrak	yellow +++
Ww 3608	St. Louis, USA, Forest Park, VIII. 1999	wood		orange-brown +++
Ww 3609	Castlewood State Park, USA; VII. 1999	*Quercus*	leg. D. Triebel & M.S.	yellow +
Ww 3643	Kamiyama-cho, Shikoku, JAPAN, X. 1999	*Quercus* sp.		orange-brown +++
Ww 3714	Bremgarten-Zopfhau, Aargau, SWITZERLAND, VII. 1999	*Fagus*	leg. R. de Marchi as *D. cf. occidentalis* , Herbar B. Senn-Irlet	yellow +++
Ww 3715	Birrhard-Rüsshalden, Aargau, SWITZERLAND, IX. 1999	*Fagus*	leg. R. de Marchi as *D. cf. occidentalis* , Herbar B. Senn-Irlet	yellow +

Species/No	Collection site/time	Substrate	Comments/References	KOH reaction
***D. clavata* Henn.**				
Ww 3708	Ganta, LIBERIA, XI.1939	wood	WSP; leg. Harley, G. W. 331 (Ju et al.,1997)	purple ++
***D. concentrica* (Bolt: Fr.) Ces. & De Not.**				
Ww 0945	Wuppertal, GERMANY, XI.1979	*Fraxinus excelsior*		purple (+)
Ww 2992	Bielefeld, GERMANY, I. 1978	wood	leg. I. & W. Sonneborn	purple +(+)
Ww 3038	Wuppertal, GERMANY, XI. 1996	*Fraxinus excelsior*	aged specimens	purple (+)
Ww 3038a	Wuppertal, GERMANY, XI. 1996	*Fraxinus excelsior*		purple ++
Ww 3080	Bielefeld, GERMANY, IX. 1996	*Fagus sylvatica*	leg. I. & W. Sonneborn	purple +(+)
Ww 3085	Neandertal, GERMANY, VII. 1994	*Fraxinus excelsior*	leg. S. Woike	purple (+)
Ww 3302	Neandertal, GERMANY, IV. 1998	*Fraxinus excelsior*	immature specimens	purple +
Ww 3316	Neandertal, GERMANY, IV. 1998	*Fraxinus excelsior*	immature specimens	purple +
Ww 3522	Wuppertal, GERMANY, XI. 1998	*Fraxinus excelsior*	immature specimens	purple +(+)
Ww 3525	Neandertal, GERMANY, XI. 1998	*Fraxinus excelsior*	immature specimens	purple +(+)
Ww 3527	Neandertal, GERMANY, VII. 1994	*Fraxinus excelsior*	leg. Dorra	purple +
Ww 3567	Neandertal, GERMANY, V. 1999	*Fraxinus excelsior*		purple +
Ww 3575	Neandertal, GERMANY, V. 1999	*Fraxinus excelsior*		purple +
Ww 3588	Coulon, FRANCE, VI. 1999	*Fraxinus*		purple +
Ww 3589	Maillezais, FRANCE, VI. 1999	*Fraxinus*		purple +(+)
Ww 3598	Pisa, ITALY, IV. 1992	*Populus*	MCT 3591, leg. F. Bellu (Lucchini, 1997)	purple +(+)
Ww 3599	Pisa, ITALY, V. 1992	wood	MCT 7087, leg. M. Marchetti (Lucchini, 1997)	purple ++
Ww 3685	Salzach-Auen, GERMANY, VIII. 1978	wood	T.R. Lohmeyer No. 78/58	purple +
Ww 3586	Angers, FRANCE, I. 1979	*Fraxinus*	T.R. Lohmeyer No. 79/1	purple +
Ww 3686	Renmore Common, Surrey, U.K., V. 1985	*Fraxinus*	T.R. Lohmeyer No. 85/30	purple +
Ww 3690	Halifax, Black Brook; U.K., IV. 1998	*Ulmus*	K(M). SE 086208 leg. & det. M.W. Sykes as *D. concentrica*	purple +

Species/No	Collection site/time	Substrate	Comments/References	KOH reaction
D. eschscholzii **(Ehrenb.:Fr.) Rehm**				
Ww 3378	Isle of Jersey, U.K., VIII. 1997	*Acer*	M, leg. H. Forstinger as *D. concentrica*	purple (+)
Ww 3518	Cubo de La Galga, Isle of La Palma, Canary Islands, SPAIN, XI. 1998	*Laurus azorica*		purple +
Ww 3551	Tokushima, JAPAN, VI. 1992	wood	Buchanan et al. (1994)	purple +
Ww 3548	Lahore, PAKISTAN, XI. 1961	*Morus alba*	M, Herbar Petrak, leg. S. Ahmad	yellow (+) => purple (+)
Ww 3563	PAPUA NEW GUINEA, VII. 1997	wood	Häffner (1999)	purple +
Ww 3591	Cienaga de Zapata, CUBA, IV. 1999	*Bucida palustris*	leg. R.F. Castaneda and C. Decock	purple +
Ww 3592	Cumanayagua, CUBA, IV. 1999	*Jambosa vulgaris*	leg. R.F. Castaneda and C. Decock	purple ++
D. fissa **Lloyd**				
Ww 1360	Wuppertal, GERMANY, IX. 1972	*Fagus*		purple +++
Ww 2042	New Forest, Shatterfordbottom, U.K., VIII. 1992	*Ulex* (burnt)		purple +++
Ww 2885	Wuppertal, GERMANY, VIII. 1996	*Fagus* (burnt)		purple +++
Ww 3034	Gruiten, GERMANY, XI. 1996	*Carpinus* (burnt)	leg. S. Woike	purple +++
Ww 3077	Hilden, GERMANY, VII. 1963	*Betula*	leg. S. Woike, immature specimens	purple +++
Ww 3105	Wuppertal, GERMANY, IV. 1997	*Fagus* (burnt)	aged specimens	purple +++
Ww 3161	Edinburgh, U.K., IV. 1979	*Ulex* (burnt)	R. Watling, Edinburgh, No. 13164	purple +++
Ww 3186	Wuppertal, GERMANY, IX. 1997	*Fagus* (burnt)		purple +++
Ww 3187	Wuppertal, GERMANY, X. 1997	*Fagus* (burnt)		purple +++
Ww 3188	Gruiten, GERMANY, IX. 1997	*Carpinus* (burnt)	immature specimens	purple +++
Ww 3189	Gruiten, GERMANY, IX. 1997	*Carpinus* (burnt)		purple +++
Ww 3191	Gruiten, GERMANY, IX. 1997	*Corylus* (burnt)	immature specimens	purple +++
Ww 3509	Düsseldorf, GERMANY, XI. 1965	*Quercus rubra*	leg. S. Woike	purple +++

Species/No	Collection site/time	Substrate	Comments/References	KOH reaction
D. fissa (continued)				
Ww 3565	Gruiten, GERMANY, V. 1997	*Corylus* (burnt)	aged stromata	purple +++
Ww 3590	Humber River, near Toronto, CANADA, IX. 1935	*Carpinus caroliniana*	M; leg. H.D. Darkis (Herbar Petrak)	purple +++
Ww 3601	Castensago, SWITZERLAND, X. 1992.	*Fagus sylvatica*	MCT 8110 (Lucchini, 1997)	purple +++
Ww 3684	Bois de Chaumont, FRANCE, II. 1979	*Betula* (burnt)	T.R. Lohmeyer and J. Mornand	purple ++
Ww 3689	Hamburg-Wandsbek, GERMANY, VI. 1977	*Carpinus betulus*	leg. T. Lohmeyer	purple +++
Ww 3693	Fairmile Common, Surrey, U.K., IX. 1996	*Ulex europaeus* (burnt)	K (M) 39.729 leg. et det. B.M. Spooner as *D. vernicosa*	purple +++
Ww 3694	Chobham Common, Surrey, U.K., VIII. 1991	*Betula* (burnt)	K (M) 17.853; leg. et det. T. Laessøe as *D. vernicosa*	purple +++
Ww 3695	Richmond, Surrey, U.K., X. 1996	*Aesculus hippocastaneum*	K (M) 40.307; leg. G.B. Butterfill; det. B.M. Spooner as *D. vernicosa*	purple +++
Ww 3697	Bradhurst, Kent, U.K., X. 1990	*Carpinus betulus* (burnt)	K (M) 16.459; leg. A. Hervica, det. T. Laessøe as *D. vernicosa*	purple +++
***D. grandis* Child**				
Ww 3700	Nuevo León state, San Roque, MEXICO	wood in oak forest	WSP, leg. R.F. Jorge, Ju et al. (1997)	purple ++
***D. lloydii* (Ju et al. 1997)**				
Ww 3547	Bad Zaizon, ROMANIA, VIII. 1883	*Betula alba*	M, leg. Römer	olivaceous +(+)
Ww 3593	Chevry Mt. NH, USA, VII. 1928	*Betula lutea*	M, leg. G. Spaulding	olivaceous ++
Ww 3594	Spittal (Drau), AUSTRIA, “before 1930”	*Betula*	M, leg. G. Niessl v. Mayendorf; immature specimens	olivaceous +++
Ww 3595	Hranice, SLOVAKIA, IX. 1938	*Betula pendula*	M, F. Petrak No. 1824; immature specimens	olivaceous +++
Ww 3610	Squaw Creek, Idaho, USA, VII. 1967	*Betula papyrifera*	WSP 57303, leg. H. Goree, Ju et al. (1997)	buff +

Species/No	Collection site/time	Substrate	Comments/References	KOH reaction
D. loculata **(Lév) Sacc.**				
Ww 0367	Wuppertal, GERMANY, X. 1970	*Betula*		purple ++
Ww 2886	Wuppertal, GERMANY, IX. 1969	*Betula*		purple ++
Ww 2987	Senne, GERMANY, III. 1991	*Betula* (burnt)	leg. I. and W. Sonneborn	purple ++
Ww 2991	Senne, GERMANY, III. 1991	*Betula*	leg. I. and W. Sonneborn	purple ++
Ww 3076	Zwillbrock, GERMANY, V. 1966	*Betula*	leg. I. and W. Sonneborn, immature specimens	purple ++
Ww 3079	Zwillbrock, GERMANY, V. 1966	*Betula*	leg. I. and W. Sonneborn	purple ++
Ww 3086	Hilden, GERMANY, X. 1971	*Betula*	leg. S. Woike	purple ++
Ww 3510	Altenberge, GERMANY, VI. 1965	wood	leg. S. Woike, immature specimens	purple ++
Ww 3578	Trinidad, California, USA, VI. 1939	*Alnus*	M, leg. H.D. Darkes and C.L. Shear as *D. occidentalis*	purple ++
Ww 3691	Pirbright, Surrey, U.K., XI. 1991	*Betula pendula* (burnt)	K (M) 18.694; leg. G. Butterfill, det. T. Laessøe as *D. concentrica*	purple ++
Ww 3696	Esher West End Common, Surrey, U.K., X. 1993	*Fagus*	K(M), leg. P.M. Kirk, det. B. Spooner as *D. concentrica*	purple ++
D. petriniae **Ju et al. (1997)**				
Ww 3039	Weingarten, GERMANY, VIII. 1997	*Alnus glutinosa*	leg. W. Winterhof, det. L. Petrini as *D. occidentalis*	grey (+) => purple (+)
Ww 3297	Ramosch, SWITZERLAND, IX. 1983	*Alnus incana*	ETH; HOLOTYPE (Ju et al., 1997)	purple (++)
Ww 3298	Untervaz, SWITZERLAND, VIII. 1982	*Alnus incana*	ETH, leg. L. Petrini & A.J.S. Whalley	purple (+)
Ww 3373	Waldkraiburg, GERMANY, X. 1972	*Alnus*	M, leg. H. Marschner (No. 397)	grey (+) => purple (+)
Ww 3374	Wertach-Auen, GERMANY, IV. 1974	*Alnus incana*	M, leg. J. Stangl	purple (+)
Ww 3375	Augsburg, GERMANY, VII. 1974	*Alnus incana*	M, leg. J. Stangl, immature specimens	yellow (+)
Ww 3376	St. Erasmus, GERMANY, IV. 1978	*Alnus incana*	M, leg. H. Marschner No. 628	purple (+)
Ww 3377	Oberammergau, GERMANY, VIII. 1889	*Alnus incana*	M, leg. Schnabel (No. 76)	purple (+)

Species/No	Collection site/time	Substrate	Comments/References	KOH reaction
D. petriniae (continued)				
Ww 3379	Spittal, AUSTRIA, I. 1900	*Alnus*	M, leg. Niessl von Mayendorf	purple (+)
Ww 3385	Kitzbuehel, AUSTRIA, I. 1897	*Alnus incana*	M, leg. Niessl von Mayendorf	purple (+)
Ww 3391	Zillertal, AUSTRIA, VIII. 1998	*Alnus incana*	leg. K. Helm	purple +(+)
Ww 3392	Zillertal, AUSTRIA, VIII. 1998	*Alnus incana*	leg. J. Keller	purple ++
Ww 3393	Jenbach, AUSTRIA, IX.1998	*Alnus incana*	leg. E. Wollweber	purple ++
Ww 3394	Wangen, GERMANY, VIII. 1998	*Alnus incana*	leg. W. Pohl	purple +(+)
Ww 3577	Newman Lake, Wa. USA, VIII. 1935	*Alnus rhombifolia*	M, leg. C.R. Stillinger as *D. occidentalis*	purple (+)
Ww 3600	Sta. Domenica, SWITZERLAND, V. 1983	*Alnus*	MCT 5796 (Lucchini, 1997)	purple (+)
Ww 3688	Irlacher Au, Salzburg, AUSTRIA, X., 1987	*Alnus*	leg. T.R. Lohmeyer (87/69)	yellow +
Ww 3604	"Mährisch Weisskirchen" CZECH REPUBLIC,, IX. 1928	*Carpinus*	M, leg. F. Petrak	purple (+) => yellow
Ww 3712	Grindelwald, SWITZERLAND, I. 2000	*Alnus incana*	aged stromata	purple (+)
***D. singularis* Ju et al. (1999)**				
Ww 3706	near Vladivostok, RUSSIA, IX.1997	*Carpinus cordata*	WSP, ISOTYPE, Ju et al. (1999)	purple (+)
***D. cf. loculata* (Petrini and Müller (1986)**				
Ww 3290	Saligues, Pyr. Atlant., FRANCE, X. 1981	wood	ETH; see Petrini and Müller (1986)	yellow +++
Ww 3291	Oloron, Pyr. Atlant., FRANCE, X. 1981	wood	ETH; see Petrini and Müller (1986)	yellow +++
Ww 3585	Bertiz, Navarra, SPAIN, VII. 1999	*Quercus petraea*	immature specimens	orange-brown +++
Ww 3586	Bertiz, Navarra, SPAIN, VII. 1999	*Quercus petraea*	fertile but aged stromata	yellow +
***Dald.* sp. nov. from *Betula* ("Scania", see Ju et al., 1999)**				
Ww 3699	Kropp, Scania, SWEDEN, XII. 1994	*Betula pendula*	leg. Hanson, S.-Å. (see Ju et al., 1999)	purple ++
Ww 3542	Wuppertal, GERMANY, I. 1999	*Betula*	aged stromata	purple +

Legends see Tab. 2

Table 2. Investigated collections of other Xylariaceae genera

Species/Herbar No	**Collection site**	**Substrate**
Biscogniauxia mediterranea (De Not.) Kuntze Ww 3343	Wuppertal, GERMANY, V. 1998	*Fagus* (burnt)
B. nummularia (Bull.: Fr.) Kuntze Ww 3263	Gruiten, GERMANY, I. 1998	*Fagus*
Entoleuca mammata (Wahlenb.: Fr.) Rogers and Ju Ww 3364	M; leg. K. Neff; det. M. Enderle, conf. A.J.S. Whalley; Stephansweiler, GERMANY, XI. 1981	*Salix*
Hypoxylon cohaerens (Pers.: Fr.) Fr. Ww 2833	Neandertal, GERMANY, XI. 1995	*Fagus*
H. fragiforme (Pers.: Fr.) Kickx STMA 96090	Stelzenberg, GERMANY, IX. 1996	*Fagus*
H. howeianum Peck Ww 3329	Wuppertal, GERMANY, IV. 1998	*Quercus rubra*
H. howeianum Peck STMA 96009	Solingen, GERMANY, IV. 1996	*Carpinus*
H. macrocarpum Pouzar Ww 3243	Neandertal, GERMANY, conf. J. Pouzar, XI. 1997	*Acer pseudoplatanus*
H. multiforme (Fr.: Fr.) Fr.Ww 3326	Wuppertal, GERMANY, V. 1998	*Betula*
H. multiforme (Fr.: Fr.) Fr.Ww 3328	Wuppertal, GERMANY, IV. 1998	*Quercus rubra*
H. rubiginosum (Pers.: Fr.) Fr. Ww 2199	Neandertal, GERMANY, XI. 1992	*Acer*
Kretzschmaria deusta (Hoffm.: Fr.) P. Martin Ww 3344	Wuppertal, GERMANY, V. 1998	*Fagus*
Nemania serpens (Pers.: Fr.) S.F. Gray Ww 3426	Jenbach, AUSTRIA, VIII. 1998	*Tilia*
Rosellinia corticium (Schwein.: Fr.) Sacc. Ww 3225	Wuppertal, GERMANY, XI. 1997	Quercus
Xylaria hypoxylon (L. ex Hooker) Grév.STMA 97080	leg. H.-V.T., Freiburg, GERMANY, IV. 1997	*Fagus*
X. longipes (Nitsch.) Dennis Ww 1937	Ratingen, GERMANY, XI.1991	*Acer*
X. polymorpha (Pers. ex Mér.) Grév. STMA 97160	leg. H.V.T., Freiburg, GERMANY, VIII. 1997	*Fagus*

Legends to Tabs. 1 and 2:

K = Kew Botanical Garden), M = Botanische Staatssammlung Munich, Germany, ETH = Eidgenössische Technische Hochschule, Zurich, Switzerland; MCT = Museo Cantonale Ticino, Switzerland; STMA = herbarium/culture collection of M.S.; Ww = herbarium of H.W. (also designation numbers for collections obtained from other herbaria); WSP = Herbarium of J.D.R.; KOH-extractable pigments:: +++ very strong; ++ strong; +(+) middle; + weak; (+) very weak; “purple” pigments range from vinaceous grey (116), vinaceous purple (101), livid purple (81), to livid violet (79) or dark purple (36); “yellow” pigments range from isabelline (65) honey (64) to cinnamon (62) to amber (47). Olivaceous pigments range from olivaceous buff (89) greenish olivaceous (90) grey olivaceous (107) to olivaceous (48). An arrow indicates changes of colour after some minutes of incubation. Colour codes are given according to Rayner (1970).

Tab. 3. List of investigated cultures

Strain No	**Species**	**Origin, substrate and further remarks**
***Daldinia* spp.**		
JDR 107	*D. bambusicola*	Tab. 1
JDR 104	*D. caldariorum*	MEXICO, SM 704, Ju et al. (1997)
ATCC 73618	*D. childiae*	JAPAN, Y. Abe
JDR 200	*D. childiae*	FRANCE, HOLOTYPE; Rogers et al. (1999)
JDR 201	*D. childiae*	FRANCE, Rogers et al. (1999)
Ww 3587	*D. childiae*	Tab. 1
Ww 3608	*D. childiae*	Tab. 1
Ww 3609	*D. childiae*	Tab. 1
Ww 3643	*D. childiae*	Tab. 1
JDR 106	*D. clavata*	MEXICO, Ju et al. (1997)
MUCL 38738	*D. clavata cf.*	P. NEW GUINEA, Van der Gucht (1994)
IMI 193348/ ATCC 36659	*D. concentrica*	*Fraxinus,* U.K., Whalley and Watling (1980)
CBS 139.73	*D. concentrica*	NETHERLANDS; G.A. de Vries
IMI 114380	*D. concentrica*	*Fraxinus,* U.K., D.A. Reid
JDR 197	*D. concentrica*	*Fraxinus,* U.K., A.J.S. Whalley (no number)
JDR 198	*D. concentrica*	*Fraxinus,* U.K., A.J.S. Whalley; 838 Ex-TPYE, Rogers et al. (1999)
Ww 3302	*D. concentrica*	Tab. 1
Ww 3316	*D. concentrica*	Tab. 1
IMI 113974	*D. concentrica.*	*Fraxinus,* U.K., P.C. Holland
Ww 3038	*D. concentrica.*	Tab. 1
Wat herb. 13985	*D. concentrica*	*Fraxinus,* U.K., Johannesson et al. (2000)
23850 (C)	*D. concentrica*	*Fraxinus,* DENMARK, Johannesson et al. (2000)
JDR 101	*D. eschscholzii*	wood, Guad 405, Ju et al. (1997)
JDR 102	*D. eschscholzii*	wood, Texas, USA; Ju et al. (1997)
JDR 105	*D. eschscholzii*	wood, THAILAND, Ju et al. (1997)
MUCL 38740	*D. eschscholzii*	wood, P. NEW GUINEA; Van der Gucht (1994)
Ww 3518	*D. eschscholzii*	*Laurus* Tab. 7
Ww 3591	*D. eschscholzii*	Tab. 1, deposited as MUCL 41778
Ww 3592	*D. eschscholzii*	Tab. 1, deposited as MUCL 41777
CBS 157.32	*D. fissa*	wood, USA, Dixon, M. Child, No 5332
Ww 2042	*D. fissa*	Tab. 1
Ww 2885	*D. fissa*	Tab. 1
Ww 3186	*D. fissa*	Tab. 1
Ww 3189	*D. fissa*	Tab. 1
Ww 3191	*D. fissa*	Tab. 1
MUCL 38739	*D. cf. grande*	P. NEW GUINEA, Van der Gucht (1994)
JDR 108	*D. grandis*	NEW ZEALAND, Ju et al. (1997)

Strain No	Species	Origin, substrate and further remarks
***Daldinia* spp. (Tab. 3, continued)**		
Ww 3691	*D. loculata*	Tab. 1
TL 4630	*D. loculata*	*Betula,* RUSSIA, Johannesson et al. (2000)
HJ 105	*D. loculata*	*Betula,* SWEDEN, Johannesson et al. (2000)
Ww 3586	*D. cf. loculata*	Tab 1 (Petrini and Müller (1986).
Ww 3585	*D. cf. loculata*	Tab 1 (Petrini and Müller (1986).
CBS 527.90	*D. petriniae*	*Alnus incana* SWITZERLAND, B. Griessner
Ww 3391	*D. petriniae*	Tab. 1
Ww 3392	*D. petriniae*	Tab. 1
Ww 3393	*D: petriniae*	Tab. 1
Ww 3394	*D. petriniae*	Tab. 1
HJ 102	*D. petriniae*	*Alnus,* SWEDEN, Johannesson et al. (2000)
HJ 103	*D. petriniae*	*Alnus,* SWEDEN, Johannesson et al. (2000)
ATCC 36660	*D. vernicosa.*	*Ulex* (burnt), U.K.,(Whalley and Watling, (1980)
JDR 103	*Daldinia spec.*	*Corylus,* RUSSIA, Rogers et al. (1999)
JDR 185	*Daldinia spec.*	*Betula,* SWEDEN, Scania, Rogers et al. (1999)
Allied genera		
Ww 3343	*B. mediterranea*	Tab. 2
Ww 3263	*B. nummularia*	Tab. 2
DSM 1533	*Entoleuca mammata*	*Populus,* GERMANY, M.E. Ostry
DSM 5012	*Hypoxylon fragiforme*	*Fagus,*GERMANY, H. Butin
STMA 96090	*H. fragiforme*	Tab. 2
Ww 3329	*H. howeianum*	Tab. 2
Ww 3335	*H. macrocarpum*	Tab. 2
Ww 3326	*H. multiforme*	Tab. 2
Ww 3328	*H. multiforme*	Tab. 2
Ww 2199	*H. rubiginosum*	Tab. 2
STMA 95006	*K. deusta*	Tab. 2
MUCL 38733	*Nemania bipapillata*	P. NEW GUINEA, Van der Gucht (1994)
Ww 3334	*N. serpens*	Tab. 2
Ww 3225	*R. corticium*	Tab. 2
ATCC 14962	*Xylaria digitata*	not stated
ATCC 42768	*X. hypoxylon*	JDR/R. Chako (RC 8008)
STMA 97080	*X. hypoxylon*	Tab. 2
Ww 1937	*X. longipes*	Tab. 2
STMA 97160	*X. polymorpha*	Tab. 2

JDR = culture collection of J.D.R.; STMA = culture collection of M.S.; for origin of other other cultures see respective references or Experimental section.

RESULTS AND DISCUSSION

A. Morphology, geographic distribution, host-specificity and stromatal pigment colour in KOH

The current study originated from a taxonomic re-evaluation of *Daldinia* spp. collected in Germany according to Ju et al. (1997). The present lack of knowledge on the distribution of *Daldinia* spp. in Central Europe became apparent as in Krieglsteiner (1993), only "*D. concentrica* ss. auct." is listed among the ascomycetes occurring in Western Germany. In fact, the observations of Ju et al. (1997) as well as those of Petrini and Müller (1986) pointed toward the existence of additional species in these regions. An examination of the Ww herbarium already revealed that at least three *Daldinia* spp. (*D. concentrica, D. fissa, D. loculata*) are present in the vicinity of Wuppertal. This prompted us to investigate several other freshly collected specimens, herbarial records and cultures from various sources. Although most materials studied were of European origin, a considerable number of records from other parts of the world were included. Unfortunately, it was not yet possible to examine both the stromata and the corresponding cultures of all species. As many of the investigated materials had been collected several years ago, they did not contain viable spores. For comparison, several strains of *Daldinia* spp. were obtained from public culture collections, but their corresponding teleomorphs were not available, and their taxonomy is not always clear. All investigated records are listed in Tabs. 1 - 3. In the following, the results on morphology, hosts and occurrence are briefly summarised for each taxon, where we found new evidence on the distribution and/or where we found it appropriate to mention previous results in relation to the discussion of data on secondary metabolites and PCR. For further information on these species (*D. bambusicola, D. singularis*), the reader is referred to Ju et al. (1997 and 1999). The stromatal pigment colour in 10% KOH is included here because of its taxonomic relevance (Ju et al., 1997). Most investigated specimens clearly showed the characteristics of previously described species according to Rogers et al. (1999). As will be seen later herein, with some of the investigated collections and cultures, it cannot be decided as now if they merely represent varieties of known species or even constitute separate species. However, the scope of the present study is not the description of new taxa. The evaluation of genetic characteristics and secondary metabolites of these fungi as alternative diagnostic tools should provide useful parameters to facilitate their future identification.

D. caldariorum Henn.

Besides its occurrence in Mexico, this species was reported from Fabaceae (*Cytisus*, *Ulex*) in Europe (Ju et al. 1997), which was confirmed by examination of Ww 3292 and Ww 3692. Ju et al. (1997) had believed this species to correspond with *D. vernicosa* ss. Whalley and Watling (1980), even though they suggested that the records from Great Britain might represent a separate taxon. This was indicated from slight morphological differences in the anamorph as compared to their *D. caldariorum* cultures and from the apparent host specificity of *D. vernicosa* ss. Whalley and Watling (1980) for *Ulex* in Great Britain. However, *D. vernicosa* is an invalid synonym of *D. fissa* (Ju et al., 1997), and the comparison of ascospore size ranges given by Whalley and Watling (1980) for *D. vernicosa* collections from *Ulex* (ranging from average sizes of 9.4 x 5.16 µm to 12.36 x 6.67 µm) implies the presence of more than one taxon. Besides *D. caldariorum* Ww 3692, we identified two collections from burnt *Ulex* as *D. fissa* (see below), while the substrates attached to the specimens of Ww 3692 (and Ww 3292) showed no sign of being damaged by fire. A culture derived from specimens found in Mexico (JDR 104) was investigated, but unfortunately, no corresponding cultures from Ww 3292 and Ww 3692 were obtained for comparison. Our investigations revealed that more than one *Daldinia* sp. is present on *Ulex* in Great Britain. Interestingly, Johannesson et al. (2000) stated that three different taxa may be present on *Ulex* in the U.K. but gave no further evidence on this subject. We examined the culture of *D. vernicosa* described by Whalley and Watling (1980) from *Ulex* in the U.K. (ATCC 36660). The ascospore size of the teleomorph corresponding to strain ATCC 36660 was reported as 8.5-12 (14.5) x 4.5-5.5 µm, which is slightly larger than typically observed in *D. caldariorum* (and found in both Ww 3292 and Ww 3692). As shown in a plate by Whalley and Watling (1980), ATCC 36660 formed a *Nodulisporium*-like conidial state. On Oatmeal agar, the culture lacked pigmentation on its reverse and showed a conidial size range of (5-7 x 3-3.5 µm). In contrast, all our *D. fissa* cultures (see below), including Ww 2042 from burnt *Ulex,* showed the characteristics reported by Ju et al. (1999). Moreover, the conidia of *D. fissa* were larger than those of both JDR 104 and ATCC 36660, measuring 5-9 (10) x 4.5-6 µm. Upon comparison of ATCC 36660 with *D. caldariorum* JDR 104, slight differences in conidial size and other morphological features of the culture were observed as well (as stated by Ju et al., 1997). Taken together with the ARDRA data (see below), these results strongly suggest that an additional species should be erected for some collections identified as *D. caldariorum* in Europe and Central America. However, this should be verified by further investigations relying on a larger number of records, including the materials studied by Whalley and Watling (1980). The lectotype from Germany selected by Ju et al. (1997) was collected in a greenhouse and probably associated with an alien host plant. Therefore, *D. caldariorum* is not yet known to occur in natural environments in Central Europe.

Stromata of Ww 3292 yielded a dense purple pigment, while the colour in Ww 3692 was weaker. This may be due to different ages of the specimens (see also *D. concentrica*).

D. childiae Rogers et al., 1999

This species was erected by Rogers et al. (1999) for the taxon previously regarded as *D. concentrica* ss. auct. *D. childiae* is widely distributed with a preference for warmer climates and no apparent host-specificity (Rogers et al., 1999). We found it to be present on *Acer*, *Alnus*, *Carpinus, Fraxinus* and *Fagus* (in Europe), and *Quercus* (in Japan and USA). Thus, *D. childiae* is herein firstly reported from Central and Southeast Europe (Austria, Romania, Switzerland). The materials referred to as *D. concentrica* by Hashimoto and Asakawa (1998) also correspond *to D. childiae*. They were included in the present investigation and found identical to those from other collection sites, thus representing the first record of the species from Japan. This species has so far not been reported from Germany.

The morphological characteristics of Ww 3295 and Ww 3296 had been described by Petrini and Müller (1986) as *D. cf. eschscholzii*; however, we found them both identical with *D. childiae*. This is in accordance with Van der Gucht (1994), who had already suggested that the taxon described by Petrini and Müller did not correspond to their *D. cf. eschscholzii*.

Two *D. childiae* cultures from France, previously studied by Ju et al. (1997) and Rogers et al. (1999), among those the ex-type culture, showed consistent morphological characteristics as compared to the newly obtained ones from the USA, Europe and Japan (*Nodulisporium*-like branching pattern, conicial size 8-10 x 4-5 µm). Strain ATCC 73618, isolated in Japan and deposited as *D. concentrica*, also showed the typical characteristics of *D. childiae*.

D. childiae differs from both *D. concentrica* and *D. eschscholzii* by the colour of KOH-extractable stromatal pigments. While the latter species have purplish pigments, the freshly collected stromata (Ww 3587, Ww 3608, Ww 3643, Ww 3714) even yielded an orange-brown pigment (which appeared yellowish upon further dilution), while the colour was isabelline or honey in aged specimens.

D. clavata **Henn.**

The morphology of this tropical stipitate *Daldinia* species has been described by Van der Gucht (1994, as *D. albozonata*) and by Ju et al. (1997), who stated that they are synonymous. Specimens from Liberia and cultures from Mexico (Ju et al., 1997) and Papua New Guinea (Van der Gucht, 1994 and 1995) were examined by us. The cultures showed similar morphology (*Nodulisporium*- like branching pattern), including similar conidial sizes. However, the culture from Papua New Guinea differed from the one from Mexico by forming smaller, less robust conidiogenous cells (never exceeding 18 µm in length). In addition, the shape of its conidia was obovoid rather than ellipsoid, as in the culture from Mexico. The investigated fruitbodies yielded vinaceous grey pigments in KOH. Unfortunately, neither a culture derived from the African fruitbodies, nor stromatal materials corresponding to the examined culture from Papua New Guinea, were available. However, Van der Gucht (1994) had studied materials from Western Africa for comparison and found their morphology in accordance with collections from Papua New Guinea, and Ju et al. (1997) found those from Africa and America rather similar. As in other tropical *Daldinia* spp., additional data should be obtained before any conclusion as to the identity of these species can be drawn.

*D. concentrica (*Bolt: Fr.) Ces. & De Not.

D. concentrica is used herein in accordance with Rogers et al. (1999) and Johannesson et al. (2000). So far, this species was only identified in Europe, where it is typically associated with *Fraxinus*. It has also been reported from *Sorbus* and *Ulmus*, and we found that it can colonise *Populus* and *Fagus* as well. Our investigations showed that the species is present in France, Italy and Germany, besides its frequent occurrence in the U.K. (Rogers et al., 1999). Several collections deposited in European herbaria as "*D. concentrica*" were found to match the characteristics of other species such as *D. childiae*, *D. eschscholzii*, *D. loculata* and *D. petriniae*. Obviously, most previous reports on this species should be regarded with great caution, and even those records of *D. concentrica* from *Fraxinus* should be re-evaluated (see *D. childiae*). However, all investigated stromata and cultures of *D. concentrica* listed in Tabs. 1 and 3 showed the typical characteristics described by Rogers et al. (1999).

Without exception, all cultures listed as *D. concentrica* in Tab. 9 formed a *Nodulisporium*-like anamorph, whose morphology was in accordance with the culture derived from the holotype material. This includes those from ATCC, CBS and IMI and the *D. concentrica* cultures previously investigated by Johannesson et al. (2000).

During field observations in Germany, we noted that *D. concentrica* becomes fertile during late spring, while other species such as *D. fissa*, *D. petriniae* and *D. loculata* preferably produce their ascospores in summer and autumn. Observations on *D. concentrica* from the same site in Neandertal (Ww 3302, 3316, 3522, 3525) throughout the fruiting period revealed that in immature specimens, the purple colour of KOH-extractable pigments was stronger than in the corresponding ascigenous fruitbodies. In general, the colour was less intense than in *D. loculata* or *D. fissa*.

D. eschscholzii (Ehrenb.: Fr.) Rehm

D. eschscholzii is a widely distributed species of subtropical and tropical climates (Van der Gucht, 1994, Ju et al., 1997). However, this species in its current sense is herein reported from Europe (Isle of Jersey), Japan, the Canary Islands and Cuba for the first time. The identification of specimens found on the Isle of Jersey suggests that *D. eschscholzii* may well be encountered in the temperate climates of Western Europe. Interestingly, the ascospore size of collections from the Atlantic region (Cuba, Jersey, Canary Islands) was determined to be (9) 10-12.5 x 5-6 µm, while specimens from the Indopacific (Japan, Pakistan, Papua New Guinea) were found to contain slightly larger spores (10) 11-12 (13) x 5-6.5 µm. The morphology of the stromata and other characteristics, however, did not differ much (but see ARDRA data below!). Especially in tropical habitats and on remote islands, it is possible that this species underwent some variation, due to evolution of host specific characters, geographic isolation and other factors.

The examined anamorphs showed a consistent morphology (*Nodulisporium* type in accordance with Ju et al., 1997), although their pigmentation varied to some extent. The typical small conidia (4.5-6.5 x 2.5-3 µm) and less robust conidiophores of the *Nodulisporium* type anamorph (as compared with the related *D. concentrica*) were noted with all investigated strains. Morphological descriptions of corresponding specimens collected in Guadeloupe, Thailand and Texas were already given by Ju et al. (1997), while the investigated culture from Papua New Guinea had been described by Van der Gucht (1994). This author had also mentioned morphological differences as compared to her "*D. concentrica*", with which we basically agree from examination of Ww 3563 from the same region (see Häffner, 1999).

Stromata of *D. eschscholzii* yielded purplish pigments in KOH, whose colours and intensities were weaker than in *D. loculata* and *D. fissa*, but similar to those observed in *D. concentrica*. According to the current definition of *D. concentrica*, this species cannot be easily distinguished from *D. eschscholzii* by the colour of stromatal pigments. However, both species differ in several morphological features: cultures of *D. eschscholzii* generally produce rather small conidia, never exceeding 6 µm in length and 3.5 µm in width. Moreover, *D. eschscholzii* is characterised by having smaller ascospores, and its stromatal surface is not crackled into a fine network in mature specimens (Ju et al., 1997).

D. fissa **Lloyd**

The gelatinous stiptitate *D. fissa*, whose morphology and occurrence in Britain has been described as *D. vernicosa* by Whalley and Watling (1980), was identified from various host plants, which is in accordance with Farr et al. (1989). For comparison, materials from various European countries and Canada (Ww 3590) were available, most of which were derived from burnt substrates (in accordance with Johannesson et al., 2000).

All anamorphs showed the same morphology as described by Ju et al. (1999). *D. fissa* always produces conidia holoblastically in sympodial sequence. Unlike in other species, the branching pattern is highly variable, ranging from *Nodulisporium*- and *Sporothrix*- to *Virgariella*-like conidiogenous structures as defined by Ju and Rogers (1996). The description of the *D. fissa* anamorph by Ju et al. (1999) was based on Ww 2899, which had been collected one year previously from the same location and substrate as Ww 2885. Specimens inhabiting burnt *Ulex europaeus* in the U.K. (Ww 2042, Ww 3161, Ww 3693) were found identical with *D. fissa.* This was confirmed by R. Watling (pers. communication) for the investigated materials from Scotland. Furthermore, strain CBS 157.32, which originated from the work of M. Child and was isolated from materials collected in the USA, also showed the same characteristics as those derived from European *D. fissa.* Thus we can conclude that *D. fissa* is the same taxon in America and Europe.

Stromata of *D. fissa* generally yielded a dark purple pigment, which was very intense in immature as well as in fertile specimens.

D. grandis Child

A *D. grandis* specimen from Mexico was examined on stromatal pigments and teleomorphic characters, while the investigated cultures were derived from collections made in Papua New Guinea and New Zealand. The morphological characteristics (including those of the teleomorph) were described by Van der Gucht (1994, as *D. cf. grande*) and Ju et al. (1997), respectively. The culture of the taxon preliminary identified as *D. cf. grande* (Van der Gucht, 1994) produced an anamorph with a *Nodulisporium*-like branching pattern as defined by Ju and Rogers (1996) and had rather small, obovoid conidia (5.5-7-5 x 3.5-5µm), while the *D. grandis* culture from New Zealand, showed a *Virgariella*-like anamorph and produced larger, more ellipsoid conidia (7.5-9.5 x 4-5 µm). Moreover, Van der Gucht (1994) reported her *D. cf. grande* to possess smaller ascospores than stated for *D. grandis* by Ju et al. (1997). Therefore, *D. cf. grande* ss. Van der Gucht (1994) constitutes a different, possibly yet undescribed species.

D. lloydii Ju, Rogers and San Martín

This species seems to be associated with *Betula* spp. and is characterised by very conspicuous polygonal scales on its stromatal surface (Ju et al., 1997), along with further morphological characters. *D. lloydii* seems to be rather rare as hitherto, it had been only recorded twice from the USA. We found that specimens from M (Ww 3547, Ww 3593, Ww 3594 and Ww 3595) revealed the typical morphological characteristics of *D. lloydii,* which was confirmed by comparison of a WSP collection treated here as Ww 3610. Hence, this species is herein firstly reported from Europe.

The imperfect state of this species is still unknown. No cultures were obtained from any of the investigated specimens. Unfortunately, it has not been collected for more than 30 years.

The KOH-extractable pigments were olivaceous in specimens deposited in M, while those described by Ju et al. (1997) were lacking apparent KOH-extractable pigments. In the immature specimens of Ww 3595, the polygonal scales on the stromatal surface were less conspicuous, while the pigment reaction was stronger as compared to other collections of *D. lloydii*. The olivaceous pigment colour might constitute a valuable additional criterion to distinguish immature *D. lloydii* from e.g. *D. loculata and D. grandis*, both of which may occur on the same substrate but yield purple pigments in KOH in contrast to *D. lloydii*). Like in *D. petriniae*, the colour of the pigment faded after some time, but in *D. lloydii* no apparent colour changes were observed.

D. loculata (Lév.) Sacc.

Until recently, this species, which is typically associated with *Betula*, had not been distinguished from *D. concentrica* in Europe. According to Ju et al. (1997), *D. loculata* may occur on *Betula* spp. and *Populus tremuloides* in the USA. Moreover, this fungus is believed to have a circumpolar distribution as it was encountered in Scandinavia, the U.K. and Far Eastern Russia (Johannesson et al., 2000), where it preferably occurs on burnt substrates. *D. loculata* is herein firstly reported from Germany. The morphology of Ww 3578 from California was similar to the ones from Europe. In accordance with Johannesson et al. (2000), most European records of *D. loculata* examined by us were derived from *Betula* spp., and some were collected from substrates which had been damaged by fire. A collection from non-burnt *Fagus* (Ww 3696) in the U.K. probably also refers to *D. loculata.* The collection contained rather smaller, broader elliptical ascospores (10.5-13 x 6-7 µm) as compared to *D. concentrica*, under which name it had been deposited at K. The specimens described as *D. cf. loculata* (Petrini and Müller, 1986) correspond to another taxon, which has close affinities to *D. childiae* (see below).

Out of the investigated stromata, we only obtained cultures from Ww 3191 (U.K). Two further cultures of this species from materials collected in Russia and Denmark were included in the study by Johannesson et al. (2000) and kindly provided to us. Their genetic fingerprints and secondary metabolite profiles were found consistent (see below). A detailed description of their anamorphic morphology will be published separately.

Like in *D. fissa*, the stromata of all developmental states of *D. loculata* generally yielded a dense purple pigment.

D. petriniae **Ju, Rogers and San Martín**

This fungus is typically associated with *Alnus* spp. and had frequently been confused with *D. concentrica* in the past. For example, reports of a *Daldinia* sp. by Breitenbach and Kränzlin (1981) from *Alnus incana* in Switzerland probably correspond to *D. petriniae* rather than *D. concentrica* because our examination of numerous collections of *Alnus*-inhabiting *Daldinia* spp. suggest that this species be common on *Alnus* in the alpine regions as well as in Southeast Europe. The morphology of all examined collections resembled the holotype (treated herein as Ww 3297). Thus, *D. petriniae* is reported herein from Austria, Germany, Romania and Slovakia for the first time. Johannesson et al. (2000) tentatively identified *D. petriniae* from *Alnus*, but included collections from *Betula* and *Corylus*. We confirmed their identity by comparing two cultures derived from specimens inhabiting *Alnus* spp. (HJ 102 and HJ 103), which were morphologically identical to our *D. petriniae* strains. Specimens from M, originally derived from *Alnus rhombifolia* in the USA (Ww 3577), are the first record of *D. petriniae* from America, which was indicated by both ascospore and stromatal morphology. However, comparative studies on anamorphic states of American *D. petriniae* are still pending for lack of culturable material.

All cultures differed from those of most other *Daldinia* spp. in producing a *Nodulisporium*-like anamorph with percurrently proliferating conidia, as stated by Petrini and Müller (1986) for their "*D. occidentalis*" and confirmed by Ju et al. (1997), who firstly recognised that the species is not identical with *D. occidentalis* ss. Child.

In *D. petriniae*, the KOH reaction of stromatal materials was inconsistent, despite the morphological similarity of all collections. Freshly collected specimens mostly yielded a purplish pigment as reported by Ju et al. (1997), while in some aged stromata pale grey or yellow pigments were observed at first, but a change of colour to purple was frequently noted if the KOH extracts were left for some minutes. This phenomenon was further investigated by HPLC analyses (see below).

D. cf. loculata **(Petrini and Müller (1986)**

Besides their D. *cf. eschscholzii* (i.e., *D. childiae*), Petrini and Müller (1986) described another species based on collections by Candoussau and Petrini in South West France (Pyrenean region) as *D. cf. loculata* Materials herein treated as Ww 3290 and Ww 3291 from ETH Zurich constitute the original records of this taxon. Furthermore, specimens showing similar morphological features were collected from *Quercus petraea* in the same geographic region (Bertíz, Navarra, Spain). Different developmental states were investigated. The fertile stromata (Ww 3586) were clavate to turbinate and tended to grow gregarious, not a single fruitbody reaching a size of 3 cm. The immature specimens (Ww 3585) resembled those firstly described by Petrini and Müller (1986). In contrast to all *D. childiae* collections, very conspicuous perithecial mounds and papillate ostioles were observed. In the natural habitat, the very young stromata had a brick colour. Upon air-drying, all fruitbodies blackened, developing a characteristic sweet odour. Droplets of an oily fluid became apparent on their surface. Extraction of the stromata with 10% KOH yielded a dark orange-brown pigment in fresh and immature specimens, but, as typically observed in *D. childiae*, the colour of KOH extracts was honey or isabelline in mature and aged stromata. The ascospore size of Ww 3586 was (12)13-15 (17) x 6-7(8) µm, which is in accordance with Petrini and Müller (1986) but slightly larger than usually found in all our collections of *D. childiae*. The correspondence of this taxon with known species (Ju et al., 1997) such as *D. loculata* and the American *D. cudonia* (i.e. *D. loculata* ss. Child) can definitely be excluded by the stromatal pigment colour in 10% KOH and morphological characteristics. It morphologically differs from typical collections of *D. childiae* by having slightly larger ascospores, very prominent perithecial mounds and further characters of the teleomorph and the anamorph, which were described in detail by Petrini and Müller (1986) in their comparison of *D. cf. eschscholzii* and *D. cf. loculata* The morphology of cultures made from Ww 3585 and Ww 3586 corresponds to the anamorphic description by Petrini and Müller (1986). According to these authors, and as a main difference from *D. childiae* cultures, smaller, less variable conidia (5.5-7 x 4-6 µm) were produced. Still, it remains to be decided whether it is justified to regard this taxon as a separate species because it might merely constitute a variety of *D. childiae*, with which it is definitely related. Comparing the variety within *D. childiae* and regarding the cosmopolitan distribution of this species, it seems probable that this taxon in its current definition actually comprises more than one species. As will be seen later herein, the methodology employed in the current study did not allow us to draw a sharp margin between *D. childiae* and the taxon corresponding *to D. cf. loculata* ss. Petrini and Müller. Further investigations on this subject are presently ongoing to define parameters that would allow for better discrimination on the species level.

Daldinia spp. from Scania and Russian Far East

With their description of *D. singularis*, Ju et al. (1999) included observations on stromata and cultures of two collections of *Daldinia* spp. from Russian Far East and Sweden (Scania). Both taxa showed morphological similarities to *D. cudonia,* but differed from this species in having only small stipes. Furthermore, the concentric zones of the yet unnamed taxa did not extend into the region of the stipes, as typically observed in *D. cudonia*. Their common features are purplish stromatal pigments in KOH and rather similar ascospore shapes and sizes. While cultures of the tropical *D. cudonia* were never before described, those of the taxa reported by Ju et al. (1999) are characterised by producing a *Nodulisporium*-like anamorph with percurrently proliferating conidia in culture, which is also a characteristic feature of *D. petriniae*. The collection from Russian Far East mainly differs from the one from Scania by having smaller ascospores and in the morphology of the conidia (Ju et al., 1999). In the present study, PCR fingerprints and secondary metabolite patterns of their cultures, as well as the stromatal pigments of the *Daldinia* sp. from Scania were examined, including HPLC analyses of stromatal extracts. *D. cudonia,* however, was not yet available to us for comparison.

A collection made in Germany (Ww 3542) from the same host genus (*Betula*) morphologically closely resembled the "Scania" taxon reported by Ju et al. (1999), with the exception that most stromata of Ww 3542 were non-stipitate. However, no cultures were obtained from the aged and weathered fruitbodies of Ww 3542, which apparently had been enduring rather low temperatures for several weeks. From the morphological similarities of Ww 3542 and *Daldinia* sp. from Scania, their correspondence with the stipitate tropical taxon, *D. cudonia,* is rather unlikely. However, more data on the distribution and variability within these fungi should be obtained before this taxon can be regarded as a new species.

B. SECONDARY METABOLITE PROFILES

As described in the Experimental section, extracts derived from stromata and cultures were studied for the occurrence of secondary metabolites, all of which had been previously reported in the literature. Chemical structures are depicted in Fig. 1, their HPLC-UV spectra are shown in Fig. 2, and their retention times (**Rt**) and HPLC-MS, MS and NMR characteristics have been summarised in Tabs. 5 - 8. Apart from the signals correlating to these metabolites, numerous additional peaks were observed in the extracts. These signals correspond to yet unidentified metabolites, part of which are presently under evaluation. The analytical data were saved in a library database of spectra and chromatograms. Tab. 4 gives a summary on the occurrence of the standards in cultures and stromata of *Daldinia* and other Xylariaceae as detected by HPLC analyses. In the following, observations on particular species and metabolites are illustrated by comparing the corresponding HPLC-UV chromatograms and UV spectra.

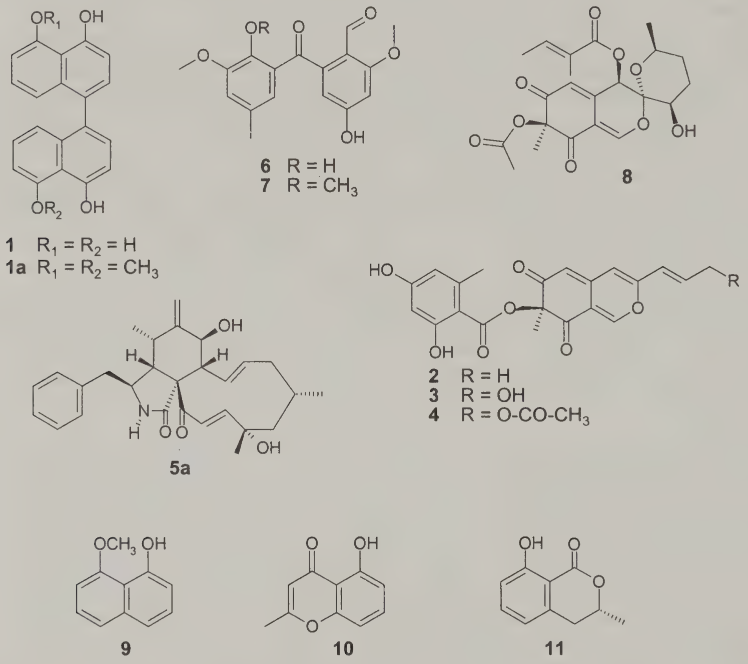


Fig.1. Structures of secondary metabolites from stromata and cultures of *Daldinia* and allies investigated in the present study. **1** = 1,1´-binaphthalene-4,4'-5,5'-tetrol (BNT); **1a** = daldinol (4,4'-dihydroxy-5,5'-dimethoxy-1,1'-binaphthyl); **2** = mitorubrin; **3** = mitorubrinol; **4** = mitorubrinol acetate; **5a** = 10-phenyl-[11]-cytochalasan A (i.e., cytochalasin I from *Daldinia* spp.); **6** = daldinal A; **7** = daldinal B; **8** = daldinin C; **9** = 8-methoxy-1-naphthol; **10** = 5-hydroxy-2-methylchromone; **11** = mellein.

Table 4. Distribution of some characteristic metabolites in the investigated species, according to HPLC-UV and HPLC-MS analyses. Numbering of compounds according to Fig. 1.

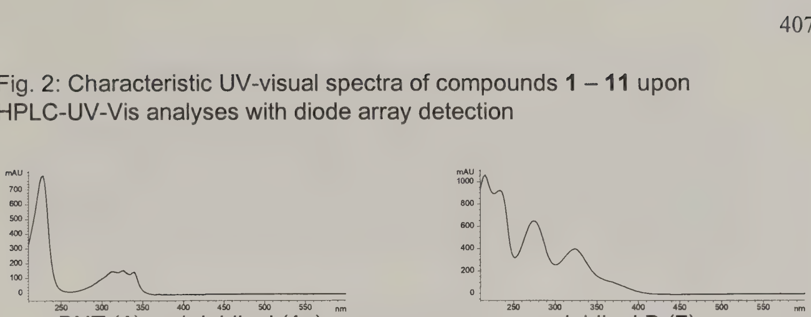
Species	From stromata				From cultures	
	1, 1a	**2 - 4**	**5a-d**	**6 - 8**	**9, 10**	**11**
Daldinia bambusicola	+	-	-	-	+	-
D. caldariorum [A]	+	-	-	-	+	-
D. childiae	+	-	-	+	+	-
D. clavata/ D. albozonata [A]	+	-	-	-	+	-
D. concentrica	+	-	(+)	-	+	-
D. eschscholzii	+	-	++	-	+	-
D. fissa	++	-	-	-	+	-
D. grandis	+	-	-	-	+	-
D. lloydii	+ [D]	-	-	-	n.e.	n.e.
D. loculata	++	-	-	-	+	-
D. petriniae	+ [D]	-	-	-	-	-
D. singularis	+	-	-	-	n.e.	n.e.
D. cf. grande [B]	n.e.	n.e.	n.e.	n.e.	+	-
D. cf. loculata” [C]	+	-	-	+	+	-
Daldinia sp. Russ Far East	n.e.	n.e.	n.e.	n.e.	+	-
Daldinia sp. Scania	+	-	-	-	-	-
D. vernicosa [E]	n.e.	n.e.	n.e.	n.e.	+	-
Biscogniauxia mediterranea	-	-	-	-	-	+
B. nummularia	-	-	-	-	-	+
Entoleuca mammata	-	-	-	-	-	-
Hypoxylon cohaerens	+	-	-	-	-	+
H. fragiforme	-	++	-	-	-	+
H. howeianum	-	++	-	-	-	+
H. macrocarpum	+	-	-	-	n.e.	n.e.
H. multiforme	++	-	-	-	-	+
H. rubiginosum	-	-	-	-	-	+
Nemania serpens	+	-	-	-	n.e.	n.e.
N. bipapillata	n.e.	n.e.	n.e.	n.e.	-	-
Rosellinia corticium	-	-	-	-	-	-
Xylaria digitata	n.e.	n.e.	n.e.	n.e.	-	-
X. hypoxylon	-	-	-	-	-	+
X. longipes	-	-	-	-	-	-
X. polymorpha	-	-	-	-	-	+

(+) tentatively identified; **+** = present; **++** = present in large amounts (more than 70% of UV absorption at 210 nm); **-** = not detected; **n.e.** = not examined; [A] = cultures and stromata not corresponding [B] = ss. Van der Gucht (1994); [C] = ss. Petrini and Müller (1986); [D] = signal overlaid by another peak corresponding to an unstable compound with similar polarity; [E] = strain ATCC 36660, see Whalley and Watling (1980).

Table 5: Retention times (Rt) of respective peaks in standard gradients and characteristic pos. ESI LC-MS signals of compounds **1** – **11**

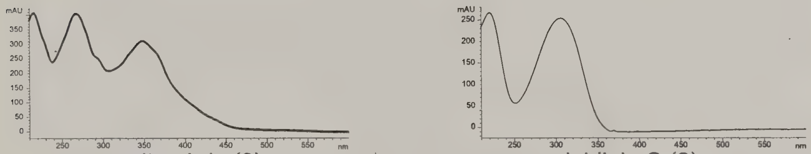
Compound	Rt (HPLC-UV) [min]	Rt (HPLC-MS) [min]	Prominent HPLC-MS signals
1	7.75 – 7.8	7.15 – 7.2	319 $[M+H]^+$; 318 $[M]^+$
1a	9.87-9.95	8.2 – 8.4	347 $[M+H]^+$; 346 $[M]^+$
2	6.9 – 6.92	6.45.	383 $[M+H]^+$; 765 $[2M+H]^+$
3	8.25 – 8.28	7.3	399 $[M+H]^+$; 797 $[2M+H]^+$
4	7.8 – 7.83	6.9 - 7.0	441 $[M+H]^+$
5a	7.5 – 7.52	7.05 –7.15	416 $[M+H-2\,H_2O]^+$; 434 $[M+H-H_2O]^+$; 452 $[M+H]^+$; 473 $[M+H+ACN-H_2O]^+$
5b	7.5 – 7.52	7.05 –7.1	414 $[M+H-2\,H_2O]^+$; 432 $[M+H-H_2O]^+$; 450 $[M+H]^+$
5c	7.48 – 7.5	7.0 –7.054	432 $[M+H-2\,H_2O]^+$; 450 $[M+H-H_2O]^+$; 468 $[M+H]^+$;
5d	7.5 – 7.52	7.05 –7.15	446 $[M+H-2\,H_2O]^+$; 464 $[M+H-H_2O]^+$; 482 $[M+H]^+$
6	7.1	5.7	317 $[M+H]^+$
7	7.25	5.75	331 $[M+H]^+$
8	7.95-8.0	6.66 – 6.7	435 $[M+H]^+$; 476 $[M+H+ACN]^+$
9	8.49 – 8.53	7.85	175 $[M+H]^+$
10	7.90	7.25	177 $[M+H]^+$
11	6.35	5.45	195 $[M+H)^+$

Fig. 2: Characteristic UV-visual spectra of compounds **1 – 11** upon HPLC-UV-Vis analyses with diode array detection



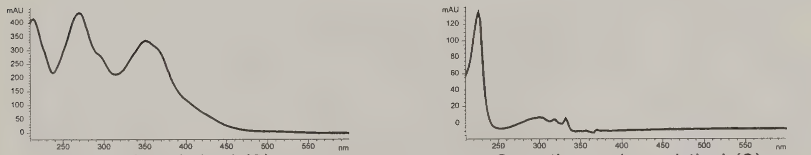
BNT (**1**) and daldinol (**1a**)

daldinal B (**7**)



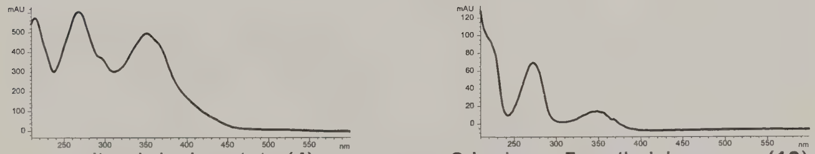
mitorubrin (**2**)

daldinin C (**8**)



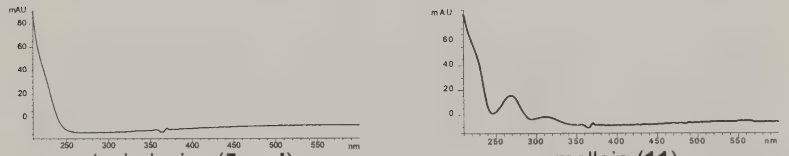
mitorubrinol (**3**)

8-methoxy-1-naphthol (**9**)



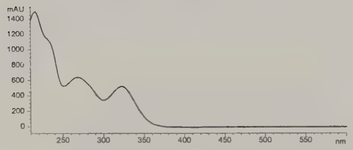
mitorubrinol acetate (**4**)

2-hydroxy-5-methylchromone (**10**)



cytochalasins (**5a - d**)

mellein (**11**)



daldinal A (**6**)

Isolation and distribution of BNT and mitorubrins

As described by Ju and Rogers (1996) and Ju et al. (1997), *Daldinia* and *Hypoxylon* spp. may yield a variety of different pigment colours in KOH. Stromatal extracts of most species within these genera were never before subjected to HPLC-UV analyses. Hence, it appeared worthwhile to examine some allied genera in comparison with *Daldinia* spp. Some of the most common Xylariaceae species in Germany were included in the present study.

Among the first secondary metabolites reported from the stromata of Xylariaceae were BNT (**1**; reported by Allport and Bu´Lock, 1958) from *Daldinia* sp. and mitorubrin type azaphilones (e.g. **2** – **4**; reported by Steglich et al., 1974) from *Hypoxylon fragiforme*. These compounds were re-isolated by us, and their structures were confirmed by spectral methods. The NMR and MS data of compounds (**1** – **4**) is given in Tabs. 5 -7. Interestingly, BNT is a rather stable marker compound because it was still detectable in well-preserved, but more than 100-year-old specimens (e.g. Ww 3377). The same appears to be true for the benzophenones (**6** and **7**), while the contents of azaphilones such as mitorubrins (**2** - **4**) and daldinin C (**8**) rapidly decreased upon ageing of the stromata.

By HPLC analysis, these compounds were detected in the extracts of several other species as exemplified below (Figs. 3 and 4) and summarised in Tab. 1. Analytical HPLC of enriched fractions from preparative HPLC (exemplified by *D. concentrica, D. fissa, H. fragiforme and H. howeianum*) verified that mitorubrins were definitely not present in BNT-containing specimens and vice versa. Moreover, these experiments clearly revealed that mitorubrins were only present in *Hypoxylon howeianum* and *H. fragiforme*, but not in *H. multiforme*, *H. macrocarpum, H. cohaerens and Nemania serpens*. Instead, the latter species, as well as all examined *Daldinia* spp. contained BNT (**1**), daldinol (**1a**) or yet unidentified metabolites with similar UV spectra (but see detailed results on *D. petriniae/D. lloydii* below). The metabolites corresponding to the additional peaks with characteristic BNT-like UV spectra remain to be identified. However, they might constitute congeners with lower polarity than BNT because they eluted at higher Rt as compared to **1** in the employed HPLC gradient.

The isolation of BNT from *Hypoxylon* is insofar not surprising as the structurally related 4,9-dihydroxyperylene-3,10-dione had been obtained from *H. truncatum* (Hashimoto and Asakawa, 1998). With the exception of *H. multiforme*, which contained BNT as single main metabolite, all extracts from *Hypoxylon* spp. and *N. serpens* showed various other peaks, and several further metabolites remain to be identified from these species. In summary, neither BNT nor mitorubrins constitute genus-specific marker compounds for *Hypoxylon* or *Daldinia*, but in both genera they might be valuable for discrimination on the species level.

Interestingly, neither of the examined *Biscogniauxia, Entoleuca, Kretzschmaria, Rosellinia* and *Xylaria* spp. contained any of these compounds and, in general, yielded smaller amounts of UV-detectable secondary metabolites than *Hypoxylon* and *Daldinia* spp. *Hypoxylon rubiginosum* definitely needs further investigations as neither BNT nor mitorubrins, but different metabolites were detected in the examined specimens. Casser (1983) had reported the species to contain mitorubrinol, which could not be confirmed in the present study.

Mitorubrinol acetate (**4**) is not restricted to *Hypoxylon* but was previously obtained from the stromata of *Entonaema splendens* (Hashimoto and Asakawa, 1998), which is remarkable as the stromata of *Entonaema* were also reported to contain naphthalene derivatives (Whalley and Edwards, 1995). According to a database search, Mitorubrin derivatives also are known to occur in *Talaromyces* spp. (Bérdy, 2000).

The purple colour of KOH-extractable pigments

All *Daldinia* spp. yielding purple KOH extractable pigments were found to contain BNT. Strong correlations between the intensity of the purplish colour and the detected amounts of BNT were noted. With several collections of aged specimens, only weak or no pigments were obtained upon extraction with either MeOH or KOH. These extracts were concentrated to allow for HPLC analyses. In general the metabolite profiles were found similar to those of the dense pigments of other species (including BNT).

Even though BNT is extractable with 10% KOH to some extent (as exemplified by *D. fissa* in Fig. 3) and has a purple colour in KOH solution, additional investigations will be necessary to establish BNT and derivatives as the sole taxonomically relevant colouring agent in these fungi. Other metabolites, which were not detectable or identified by the employed HPLC method, may also contribute to the colour reaction. This applies to those taxa in which the colour of KOH extractable stromatal pigments is other than purple (several of those have not yet been examined by HPLC). In all examined *Daldinia* spp. the purple colour of the KOH extracts eventually faded or disappeared some hours after extraction. In contrast, MeOH extracts kept their yellowish brown colour for several days and turned dark brown instead of purple when adding 10% KOH. The corresponding stromata of species belonging to genera other than *Daldinia* were not examined on their KOH extractable pigments. Hence, it remains to be clarified why the MeOH extract of *N. serpens* yielded BNT (among other compounds), while this species is known to produce no KOH extractable pigment at all (Ju and Rogers, 1996).

In general, many secondary metabolites cannot be expected to remain stable in alkaline solution such as 10% KOH, while they may be kept for several days in MeOH. Actually, mitorubrin decayed immediately after adding 10% KOH to its dilute MeOH solutions, resulting in a change of colour from yellowish to orange-brown. Thus, the colouring agents observed upon extraction with KOH may in some instances be due to the decay of unstable constituents such as azaphilones.

Table 6: Mass spectrometric data of BNT (**1**) and mitorubrins (**2** – **4**)

Compound	**1**	**2**	**3**	**4**
ESI	319 [M+H]$^+$	405 [M+Na]$^+$ 383 [M+H]$^+$	399 [M+H]$^+$	441 [M+H]$^+$
ESI-HR-MS	n.e.*	$C_{21}H_{19}O_7$ [M+H]$^+$ Found: 383.1148 Calcd.: 383.1131	$C_{21}H_{19}O_8$ [M+H]$^+$	$C_{23}H_{21}O_9$ [M+H]$^+$ Found: 441.1191 Calcd.: 441.1186

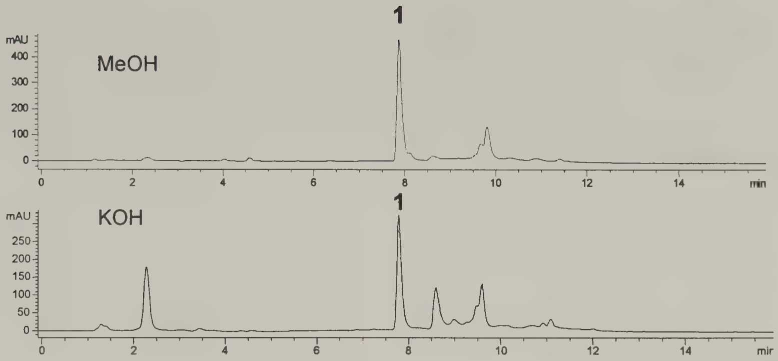
*. = not examined

Table 7: ^{1}H-NMR and ^{13}C-NMR data of BNT (**1**). [ppm]

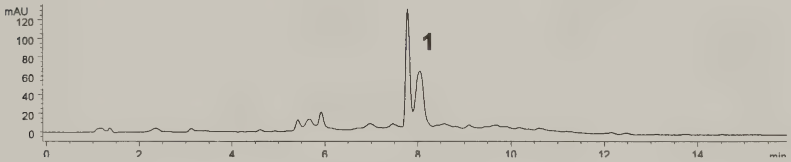
	^{1}H	^{13}C
1 / 1’		129
2 / 2’	7.16 (d, *J* = 8 Hz, 2H)	129
3 / 3’	6.82 (d, *J* = 8 Hz, 2H)	107
4 / 4’		154
4a / 4a’		115
5 / 5’		155
6 / 6’	6.70 (d, *J* = 8 Hz, 2H)	108
7 / 7’	7.06 (dd, *J* = 8 and 8 Hz, 2H)	126
8 / 8’		118
8a / 8a’		136

Table 8: ^{1}H-NMR data of mitorubrins (**2** - **4**) in CD_3OD [ppm]

	2	**3**	**4**
1	8.18 (br. s, 1H)	8.19 (br. s, 1H)	7.95 (br. s, 1H)
4	5.63 (d, *J* = 1 Hz, 1H)	5.77 (d, *J* = 1 Hz, 1H)	5.62 (d, *J* = 1 Hz, 1H)
5	6.20 (br. s, 1H)	6.40 (m, 1H)	6.15-6.35 (m)
7-CH_3	1.63 (s, 3H)	1.77 (s, 3H)	1.62 (s, 3H)
1’	6.15 (dq, *J* = 16 and 1.5 Hz, 1H)	6.30 (m, 1H)	6.15-6.35 (m)
2’	6.68 (dq, *J* = 16 and 7 Hz, 1H)	6.85 (dt, *J* = 16 and 7 Hz, 1H)	6.57 (dt, *J* = 16 and 7 Hz, 1H)
3’	1.94 (dd, *J* = 7 and 1.5 Hz, 3H)	4.42 (m, 2H)	4.73 (dd, *J* = 6 and 2 Hz, 2H)
4”	6.25 (br. s, 1H)	6.52 (br. s, 1H)	6.15-6.35 (m)
6”	6.48 (br. s, 1H)	6.52 (br. s, 1H)	6.15-6.35 (m)
7”-CH_3	2.60 (s, 3H)	2.73 (s, 3H)	2.58 (s, 3H)

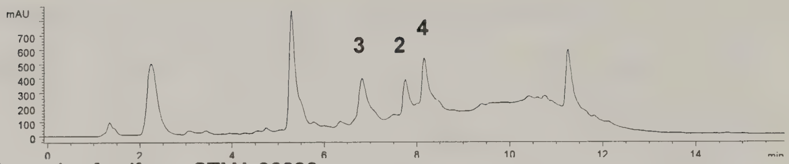


D. fissa Ww 2885 from burnt *Fagus* MeOH and KOH extract

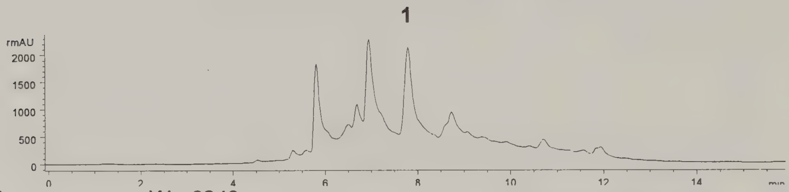


D. concentrica Ww 3302 from *Fraxinus*: MeOH extract

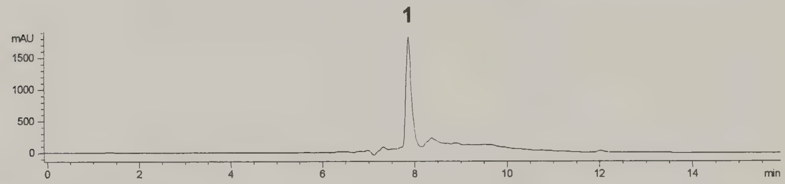
Fig. 3. Typical HPLC-UV chromatograms (210 nm) of extracts prepared from *Daldinia* spp. yielding purple KOH extractable pigments and containing BNT (**1**). above: MeOH extract and corresponding KOH extract of *D. fissa* (strong purple pigment). Below: *D. concentrica* (weak purple pigment) Corresponding UV spectrum see Fig. 2.



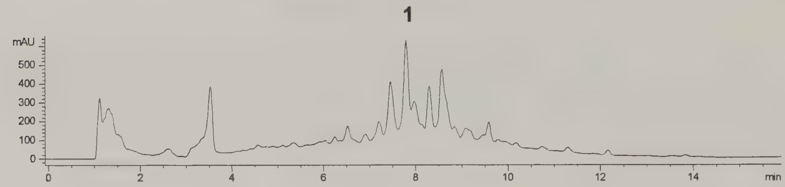
Hypoxylon fragiforme STMA 96090



H. macrocarpum Ww 3243



H. multiforme Ww 3326

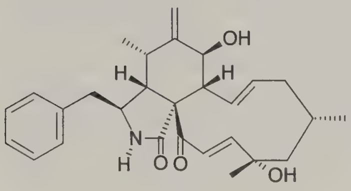


Nemania serpens WW 3426

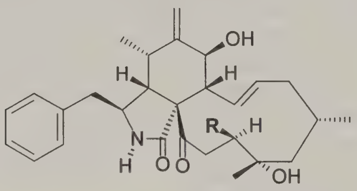
Fig. 4. HPLC-UV chromatograms (210 nm) of stromatal extracts from *Hypoxylon* and *Nemania* spp., containing BNT (**1**) or mitorubrins (**2** – **4**). Corresponding UV spectra see Fig. 2.

Cytochalasins in *D. eschscholzii* and *D. concentrica*

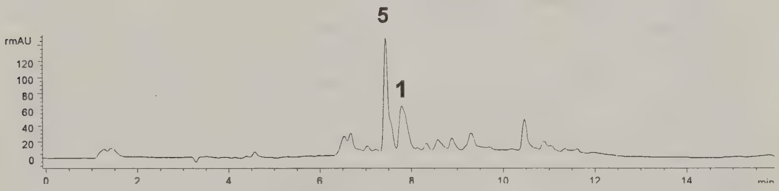
Numerous metabolites of the cytochalasin type of terpene alkaloids are known from Xylariaceae such as *Hypoxylon* and *Xylaria* spp. (e.g. Espada et al., 1997; Edwards et al., 1989; Dagne et al., 1994). However, most reports on the occurrence of these compounds were dealing with mycelial cultures, and they were only isolated once from stromata of a *Daldinia* species collected in Japan and tentatively identified as *D. vernicosa* (Buchanan et al., 1994; Hashimoto and Asakawa, 1998). Four cytochalasins (**5a** – **5d** in Fig. 5) were unequivocally identified in the crude extracts by comparison with standards derived from authentic materials (Ww 3551). Actually, 16 metabolites of this type had been isolated from this fungus (Hashimoto and Asakawa, 1998), which had afforded the collection of rather large amounts of crude materials. Morphological re-examination of the fruitbodies investigated by Buchanan et al. (Ww 3551) revealed the typical characteristics of *D. eschscholzii.* By HPLC-UV (Fig. 5) and HPLC-MS analyses, the same or similar metabolites were detected in collections of *D. eschscholzii* from other countries of origin. In addition to the cytochalasins, BNT (**1**) was always present in extracts of *D. eschscholzii*, but mostly did not constitute a main metabolite.



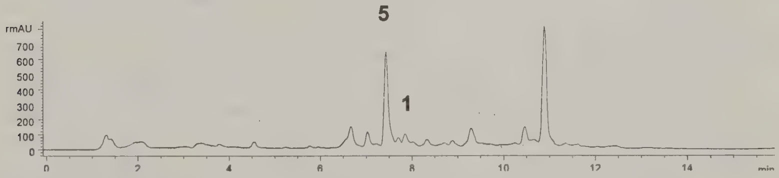
5b



5a R = H
5c: R = OH
5d: R = OCH_3



Ww 3563 from Papua New Guinea



Ww 3551 from Japan

Fig. 5. Structures of cytochalasins (**5** = **5a** - **5d**) detected in the present study and HPLC-UV chromatograms (210 nm) of stromatal MeOH extracts of *D. eschscholzii,* containing cytochalasins (**5**) and BNT (**1**). Corresponding UV spectra see Fig. 2.

Cytochalasins are not stromatal pigments. Their HPLC-UV-Vis spectra do not contain any characteristic maxima but mainly end adsorption and were thus difficult to interpret. According to HPLC-MS analyses, the typical peak observed in the range of Rt = 7.5 min in the HPLC-UV diagrams (Fig. 5) actually constitutes an overlay of several members of the cytochalasin family as the main mass peak was always accompanied by several other signals. Moreover, the analysis of cytochalasins was obstructed by their high fragmentation upon HPLC-MS ionisation (see Tab. 2), which can be explained by the loss of water and the addition of acetonitrile, respectively. The HPLC-MS data point toward cytochalasin **5a** in Fig. 1 as the main compound of this type in *D. eschscholzii.*

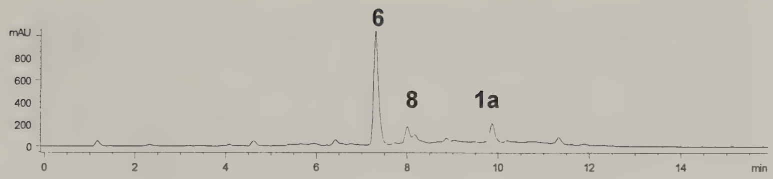
According to preliminary results, stromata of *D. concentrica* may also contain small amounts of cytochalasins. Among the minor metabolites of this species, mass peak signals which might correspond to the ones observed for **5a** – **5d** were noted upon HPLC-MS analyses. However, in stromatal extracts of *D. concentrica*, and, to a lesser extent, *D. eschscholzii*, the peak at Rt = 7.5 min (i.e., the polarity range of cytochalasins), showed main HPLC-MS signals at m/z = 493 and m/z = 511, suggesting an overlay with another, yet unidentified main metabolite with similar polarity. The identification of this compound will probably demand considerable analytical and preparative work. Further studies are pending. The fact that more than 70 natural derivatives of the cytochalasin family have hitherto been reported (Bérdy, 1999) gave reason for a careful interpretation as to the identification of this class of metabolites by HPLC-MS methodology.

Azaphilones and benzophenones in yellow-pigmented *Daldinia* spp.

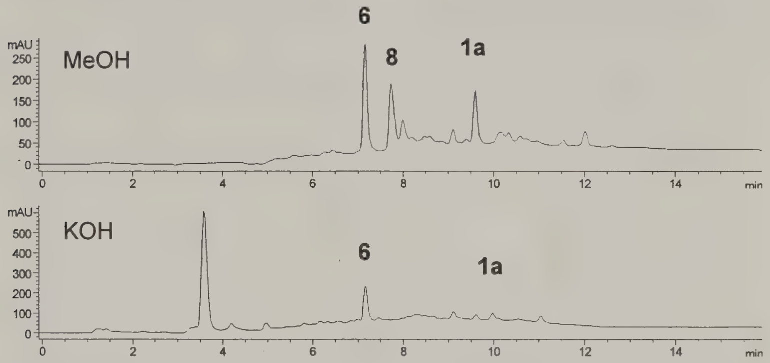
Azaphilones and benzophenones were only detected in *Daldinia* spp. yielding yellowish or orange-brown pigments in KOH (Fig. 6). These metabolites had been firstly isolated by Hashimoto et al. (1994) from a Japanese *D. childiae* (herein treated as Ww 3550). Compounds **6** and **8** were detected in all collections herein assigned to *D. childiae* and *D. cf. loculata* (Petrini and Müller, 1986), but not in any other species. Daldinal B (**7**) always constituted a minor metabolite. During HPLC-UV analysis in the employed system, the compound was obviously contained in the large peak corresponding to the main product **6**. However, **7** separated better from **6** in the employed HPLC-MS system, and its presence as minor metabolite was revealed from comparison of chromatographic and spectral data with those of the purified external standard.

Definitely, the colour of extracts is correlated with the concentration of benzophenones and azaphilones. Especially in freshly collected, immature specimens containing the anamorph, rather large amounts of these compounds were detected, and thus the extracts had to be diluted for HPLC analysis. This suggests their preferential production during conidia formation. In aged and dried specimens, the yields were rather low, and a yellowish colour was observed in KOH extracts instead of the orange-brown pigment of immature fruitbodies. Daldinal A (**6**) was detectable even in 10% KOH extracts, while the azaphilone **8** was not even encountered in those KOH extracts injected immediately after their preparation from specimens whose corresponding MeOH extracts contained large amounts of the compound.

As azaphilones do not appear to be stable in KOH, not the compound itself but their degradation products might contribute to the yellowish or orange-brown colour of the 10% KOH extracts. A major peak at Rt = 3.6 min (see Fig. 6), was absent in MeOH extracts but constituted a main metabolite in 10% KOH. This signal may represent such a degradation product.



D. childiae Ww 3295



D. cf. loculata ss. Petrini and Müller (1986) Ww 3585: MeOH and KOH-extracts

Fig. 6. HPLC-UV chromatograms (210 nm) of *Daldinia spp*. yielding yellowish pigments in KOH and containing azaphilones (**8**), benzophenone (**6**) and daldinol (**1a**). Corresponding UV spectra see Fig. 2.

Interestingly, daldinol (**1a**) was present in extracts of most specimens of *D. childiae* in higher concentrations than BNT (**1**). Hence, *Daldinia* spp. yielding yellowish KOH-extractable pigments also contain binaphthyl derivatives, even though the yellowish pigments are prevailing. Other species yielding yellowish pigments in KOH (such as *D. bakeri* and *D. mexicana*) were not yet examined but are likely to contain similar compounds.

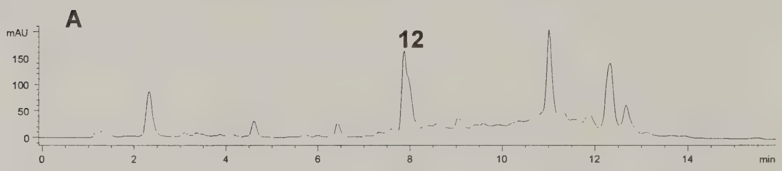
From a biogenetic view, the difference between purple- and yellow-pigmented *Daldinia* spp. is due to the presence or lack of at least one additional biosynthetic pathway in species showing yellow pigments.

Neither the benzophenones (**6** and **7**) nor daldinin C (**8**) constitute naphthalene derivatives. While benzophenones of the former type so far were not even obtained from other Xylariaceae spp. and therefore appear to be rather unique fungal metabolites, daldinin C (**8**) and its congeners reported by Hashimoto et al. (1994), as well as the mitorubrins, belong to the more widely distributed azaphilone type of secondary metabolites. Azaphilones are apparently common in Xylariaceae, although our results suggest that their production not be constant within or restricted to particular genera and species. So far, they were most frequently found in cultures of Eurotiales and associated anamorphs, according to a natural products database search (Bérdy, 1999). Apart from Xylariaceae such as *Daldinia* and *Entonaema* (Hashimoto and Asakawa, 1998), their presence in ascomycete fruitbodies was reported in *Bulgaria inquinans.* In contrast to the Xylariaceae, *Bulgaria* contains the same main metabolites in both cultures and stromata (Stadler et al., 1995). *Bulgaria inquinans* and the

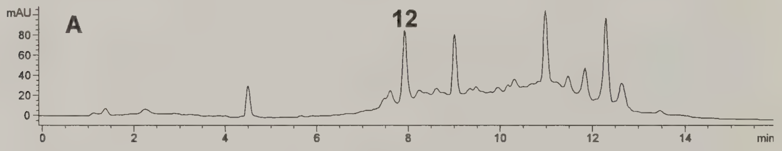
Xylariaceae seem to possess a similar secondary metabolism because binaphthyl derivatives were identified from this species as well (Gill and Steglich, 1987).

Still, little is known on secondary metabolites in the fruitbodies of ascomycetes. The requirement for rather large amounts of extractable starting materials has so far prevented studies on the secondary metabolism of small ascomycete fruitbodies. For HPLC-based analytical methods, the necessary quantities have decreased substantially, now facilitating the examination of even inconspicuous species.

Metabolite patterns in *D. petriniae* and *D. lloydii*

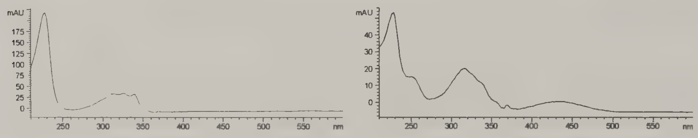


D. petriniae Ww 3392 (*Alnus incana*, Austria)



D. lloydii Ww 3595

Fig. 7a. HPLC-UV chromatograms (210 nm) of MeOH extracts (5 µg) prepared from stromata of *D. petriniae* and *D. lloydii*. Standard gradient (**A**), showing the peak **12**, which was further resolved below.



UV spectrum of BNT (**1**) UV spectrum of peak **12a**

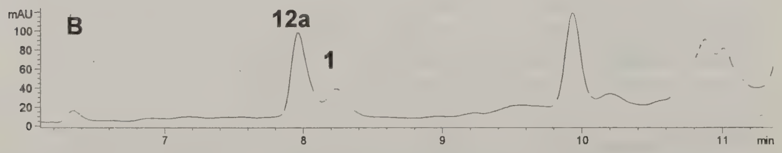


Fig. 7b. Section of a HPLC-UV chromatogram (210 nm) of *D. petriniae* Ww 3392 with altered gradient (**B**), resulting in separation of BNT (**1**), represented by the peak at Rt = 8.15 min from the unidentified compound, represented by peak (**12a**) Rt = 7.95 min. Corresponding UV spectra are depicted above the chromatogram.

D. petriniae showed inconsistent KOH reactions as well as remarkable differences in its secondary metabolite profiles as compared to other species of the genus. The taint of yellowish pigments observed in the KOH extracts of some collections did not correspond to compounds (**6** – **8**). The same is true for *D. lloydii*, which yielded olivaceous or no pigments in KOH. In both species, HPLC analyses of MeOH extracts revealed a specific peak with about the same retention time as BNT (**1**) in the employed standard gradient system.

The corresponding UV-VIS spectrum of peak (**12**) in Fig. 7a resulted from an overlay of BNT with another metabolite of very similar polarity. This was established by analysing the same extract using a slightly modified gradient, which resulted in separation of peak **12** into BNT (**1**) and another peak **12a** (see Fig. 7b). Unfortunately, **12** decayed after some hours in MeOH at room temperature, leaving BNT (**1**) in the extract. So far, all attempts to isolate the unstable component **12** by preparative HPLC did not prove successful, due to lack of sufficient starting materials. Not even a HPLC-MS spectrum of **12** was observed as the compound apparently did not ionise in the positive ESI detection mode or decayed during chromatography under mildly acidic conditions. Extracts from *D. lloydii* even showed additional compounds with UV maxima similar to **12**. However, we preferred to save the valuable reference material of this rare and unique species rather than to attempt to isolate apparently unstable compounds.

Secondary metabolism in cultures of *Daldinia* and allies

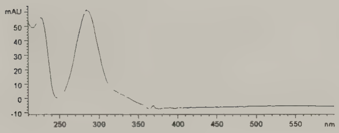
Besides important groups within the Trichocomaceae (Eurotiales), the Xylariaceae belong to the few families of ascomycetes whose secondary metabolism has been studied intensively on its taxonomic value (Frisvad et al., 1998). Whalley and Edwards (1995) had already compared the secondary metabolism of several Xylariaceae genera and species in static culture and concluded that secondary metabolites within this family "*should be looked upon in concert.*" This was accomplished in the present study, including both metabolite patterns in fruitbodies and corresponding mycelial cultures. Our fermentation conditions differed from those employed by Whalley and Edwards (1995): we used a medium of higher nitrogen content (supplying yeast extract) and a submerged fermentation technique, which allowed for faster growth because the cultures were better saturated with oxygen Under similar fermentation conditions, a *Daldinia* sp. (Stadler, 1993) and other Xylariaceae (Schneider, 1996) had previously been shown to reach the optimum of secondary metabolite production after 9-11 days, and the strains investigated were treated accordingly. Furthermore, we extracted the freeze-dried cultures with MeOH (and not fresh cultures with ethyl acetate), which should facilitate the detection of metabolites belonging to a broad polarity range.

In accordance with Whalley and Edwards (1995), dihydroisocoumarins of the mellein (**11**) type were detected in shake cultures of *Hypoxylon* and *Biscogniauxia* spp. This was established using the HPLC-UV gradient system previously described by Schneider (1996). We could not detect any peaks with mellein-like UV spectra in *Entoleuca mammata* and *Xylaria* spp. under the chosen conditions. Schneider (1996) had also reported mellein derivatives in only few out of several investigated *Xylaria* spp. In accordance with Whalley and Edwards (1995), further peaks, which might correspond to mellein derivatives as suggested by their characteristic UV spectra, were detected in *Hypoxylon* spp. However, these results are only included here to demonstrate that dihydroisocoumarins were never encountered in extracts from *Daldinia* spp., which appears to be of taxonomic relevance.

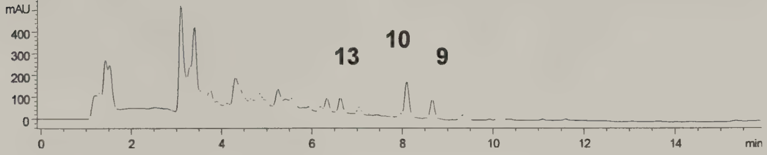
As characteristic metabolites, 8-methoxy-1-naphthol (**9**) and 2-hydroxy-5-methylchromane (**10**) were isolated from *Daldinia* by Allport and Bu´Lock (1960), and their analytical HPLC data were reported in the course of their isolation from a *Daldinia* sp. (Stadler, 1993, Anke et al., 1995). The production of **9** and **10** is not genus-specific but both metabolites were encountered in all *Daldinia* spp. possessing sympodially proliferating conidiogenous structures. They were not detected in cultures of *D. petriniae* and *Daldinia* sp. from *Betula* ("Scania"), but present in the *Daldinia* sp. from Russian Far East as the only species forming conidia from percurrently proliferating conidiogenous cells. This suggests differences between both yet unnamed taxa, described by Ju et al. (1999), despite their morphological similarities.

Besides compounds **9** and **10**, additional metabolites were detected in cultures of the species yielding yellowish pigments upon stromatal extraction with KOH. Cultures of *D. childiae* and *D. cf. loculata* (Petrini and Müller (1986) showed additional metabolites which were not present in any other investigated species (Fig. 8). Obviously, the secondary metabolism of these taxa differs in stromata as well as in submerged cultures. However, the identification of these specific metabolites from cultures of *D. childiae* is pending.

Compounds (**9**) and (**10**) are polyketides generated via the same pathway involved in melanin biosynthesis. The naphthalene derivative **9**, as well as BNT (**1**) and daldinol (**1a**) are structurally related to **DHN** (1,8-dihydroxy-naphthalene), the common precursor of melanin in ascomyceteous fungi (Wheeler, 1983; Gill and Steglich, 1987). Accordingly, **9** and **10** were found mostly in those cultures that became dark with age, accompanied by several yet unidentified metabolites, whose UV spectra suggest that they constitute pigments as well (i.e., they have UV maxima in the visual range above 360 nm). Investigations are presently ongoing to prove their identity with further compounds published by Allport and Bu´Lock (1960). The results compiled in Tab. 4 actually suggest the presence of an enzmatic system for dimerisation of DHN in stromata of *Daldinia* and other BNT containing allies, which is absent or not active in the investigated *Xylaria*, *H. fragiforme* and other species found devoid of BNT. In cultures of *Daldinia*, the presence of **9** and **10** could consequently be explained as potential "shunt metabolites" of melanin biosynthesis, derived from enzymatic conversion of DHN. These aspects were, however, not studied in detail, and DHN was never detected in the cultures we studied.

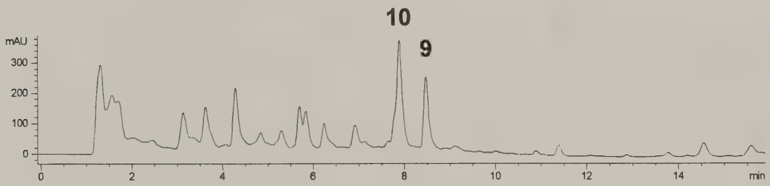


UV spectrum of peak **13** (Rt =6.890 min)



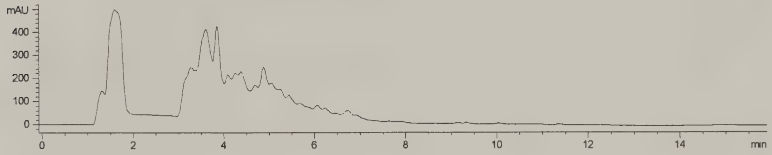
D. childiae JDR 200

a) *Daldinia* spp. with yellow stromatal pigments in KOH, producing conidia from sympodially proliferating conidiogenous structures



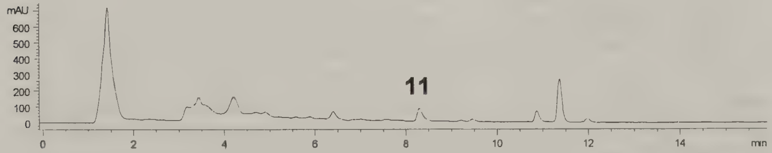
D. fissa Ww 3188

b) *Daldinia* spp. containing purple stromatal pigments in KOH, producing conidia from sympodially proliferating conidiogenous structures



D. petriniae CBS 527.90

c) *Daldinia* spp. containing purple stromatal pigments, producing conidia from percurrently proliferating conidiogenous structures



d) *Hypoxylon fragiforme*, DSM 5012, containing mellein (**11**)

Fig. 8. Examples for HPLC-UV chromatograms (210 nm) of crude extracts from MeOH extracts of submerged cultures of several *Daldinia* spp. and *H. fragiforme*.

Cytochalasins were (so far) not detected in cultures of any of the investigated *Daldinia* spp., despite the fact that they are present in fruitbodies *of D. eschscholzii* and a large number of such compounds have previously been isolated from cultures of *Xylaria* and *Hypoxylon* spp. (Schneider, 1995; and references therein). So far, we studied only one culture medium and one standard method for propagation. Therefore, it cannot be excluded that xylariaceous fungi might produce the same main compounds that are prevailing in their stromata, using different fermentation conditions. For example, it might be rewarding to study a larger variety of culture media, propagating the cultures in static or solid-state culture for comparison.

In principle, we agree with the Whalley and Edwards (1995) that "*in Xylariaceae the production of secondary metabolites is a constant and reliable feature.*"

C. GENETIC FINGERPRINTING (ARDRA)

Restriction analysis of the 18S rDNA was carried out employing three different restriction endonucleases for partial digestion of PCR amplification products. After separation and detection of fluorescently labelled digestion products, the resulting patterns were combined into one profile per strain. These profiles were grouped according to their similarity. The present paper contains results on all *Daldinia* spp. and species of allied genera from which DNA suitable for ARDRA was obtained. However, in some instances (especially with aged and freeze-dried stromata), we either obtained no DNA at all or observed extensive fragmentation. This may have been due to decay of DNA during drying and storage of the specimens. The employed methodology, however, always was satisfactory for freshly collected stromata and with all equivalent cultures listed in Tab. 3.

As shown in Tab. 9, the DNA amplification products obtained by PCR already varied in size. The sizes of these products were determined by conventional gel electrophoresis, employing size standards in the range of 0.5 kb to 10 kb as a basis for regression analysis. In Tab. 9, these data have been correlated with the ARDRA pattern types shown in Fig. 9. Actually, these results were confirmed in several species in independent experiments, comparing different strains and, occasionally, stromatal materials of the same species. For example, all cultures of *D. concentrica, D. fissa* and *D. childiae* (see Tab. 3) showed consistent ARDRA patterns, independently from geographic regions or hosts.

The dendrogram in Fig. 9 shows the calculated similarities between the profiles found within the investigated collective of strains. The observed fragmentation patterns are shown separately for each enzyme in the centre columns of Fig. 9. In most cases, partial digestion of the 18S rDNA produced only rather few signals. Hence, similar or identical patterns were obtained for many species (e.g. pattern type A), and the maximum divergence was calculated to be less than 50%. This reflects the close relationship of the examined taxa. Hence, the dendrogram in Fig. 9 could not resolve the intrageneric and intergeneric relationships as established by morphological data. However, the method proved useful to identify some taxa that apparently show specific genetic fingerprints. In the following, some results are discussed in detail.

Table 9: ARDRA pattern types and fragment sizes of PCR products, estimated from the electrophoretic mobility of the amplified, undigested 18S rDNA segments delimited by the primers NS1 and RDR116. All Xylariaceae cultures listed in Tabs. 1-3 were investigated.

Profile type.	Species	Size of amplified fragment (kb)
A	*D. bambusicola* *D. caldariorum* *D.* cf. *clavata* (MUCL) *D. concentrica* *D. eschscholzii* p.p. (Canary Islands) *D. grandis* *D.* cf. *grande* (MUCL) *D. petriniae* *Daldinia* sp. Scania *Hypoxylon* spp. *Xylaria* spp.	1.2
A	*D. eschscholzii* p.p. (Cuba)	1.6
B	*Biscogniauxia* spp.	1.2
C	*D. childiae* *D.* cf. *loculata*. (Petrini and Müller, 1986)	1.8
D	*D. eschscholzii* p.p. (Asia, USA) *D. clavata* (Mexico)	1.8
E	*Daldinia* sp. Russ Far. East	1.8
F	*D. fissa*	1.8
G	*D. vernicosa* ATCC 36660	1.4
H	*D. loculata*	2.8
I	*Entoleuca mammata*	1.2
K	*Kretzschmaria deusta*	1.2
L	*Nemania* spp.	1.2
M	*Rosellinia corticium*	1.2

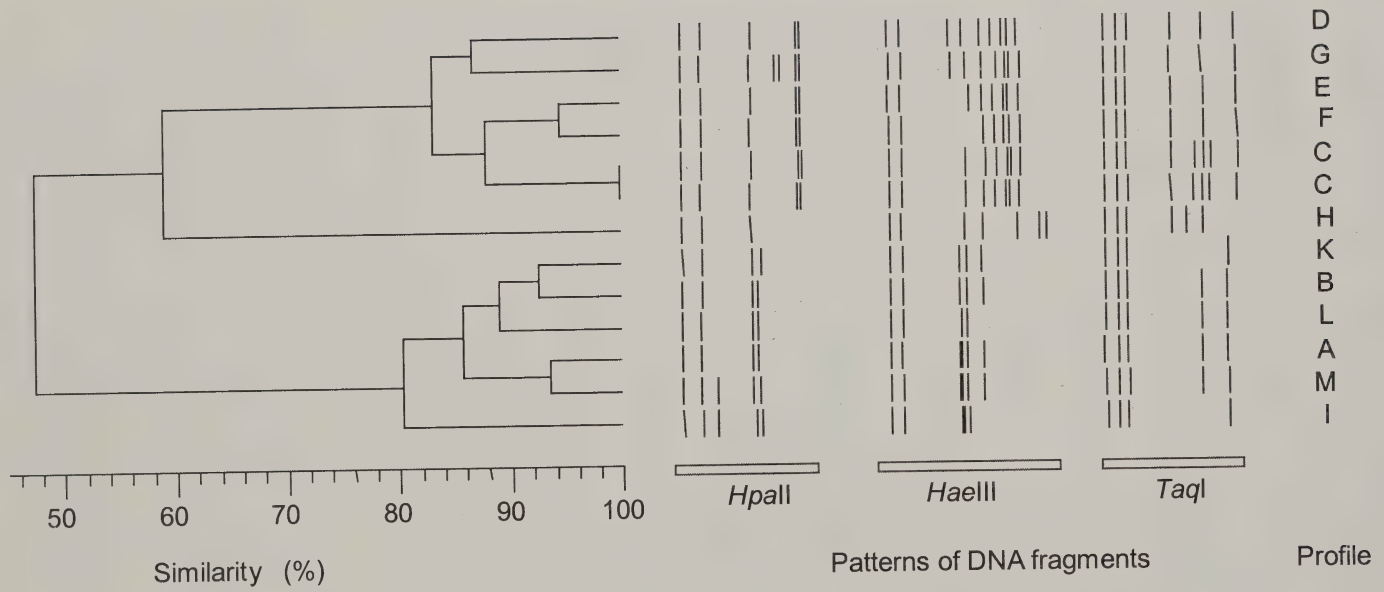


Fig. 9. Dendrogram (left) comparing the results of ARDRA (centre) in all investigated Xylariaceae (right; profile types according to Tab. 6). central part shows the profiles combined from the three ARDRA patterns obtained with *Hpa*II, *Hae*III, and *Taq*I, respectively. One example is shown for each profile type (A - M) except for type C. Here, the upper example is derived from *D. childiae*, the other from *D. cf. loculata* ss. Petrini and Müller. The close relationship between both species is reflected by the high similarity of their ARDRA patterns (which are otherwise unique within Xylariaceae)

In a group comprising several taxa of *Daldinia* (but among those only one of the *D. eschscholzii* strains, namely Ww3518), as well as all examined *Hypoxylon* and *Xylaria* spp., a similar size of the undigested PCR fragment and exactly the same ARDRA patterns (A in Tab. 9/Fig. 9) were observed: Four signals equivalent to restriction sites were obtained from digestion with *Hpa*II, six such signals were noted after digestion with *Hae*III and five signals with *Taq*I.

Within the group of species with ARDRA profile type A, only the *D. eschscholzii* isolates Ww 3591 and Ww 3592 from Cuba showed a larger amplified fragment than the usually observed 1.2 kb. (Tab. 9). In the remaining groups (B - H in Tab. 6/Fig. 9), a larger amplified DNA portion was observed, while groups I, K, L and M only differed in the ARDRA patterns as compared to group A.

Less than 90% similarity to the majority of isolates were revealed by ARDRA with *Entoleuca mammata*, *Nemania bipapillata*, *Daldinia sp.* from Russian Far East, *D. childiae*, *D. loculata* cf. ss. Petrini and Müller (1986), *D. loculata*, *D. fissa, D. vernicosa* ATCC 36660 and part of the investigated isolates of *D. eschscholzii*. As shown in Fig. 9, the ARDRA patterns obtained with these fungi contained several additional signals, which indicates significant differences in their 18S rDNA genes as compared to the remaining species.

Interestingly, *D. vernicosa* (ATCC 36660) showed strong differences to *D. caldariorum* JDR 104, suggesting that these taxa are not identical, despite their morphological similarities. The ARDRA patterns of ATCC 36660 also differed from the general *D. fissa* fingerprints. The 18S rDNA fragments amplified from *D. fissa* and ATCC 36660 are larger than those obtained from *D. caldariorum* JDR 104, pointing toward a specific insertion in *D. fissa* and ATCC 36660, which is not present in the *D. caldariorum* JDR 104. As in other fungi listed in groups B-M (Tab. 6), the presence of such an insertion explains the more complex restriction patterns, which are due to additional cleavage sites within the inserted DNA segment(s).

The examination of several cultures of *D. eschscholzii* from different geographic locations resulted in three different sizes of amplified 18S rDNA gene segments and two groups of restriction patterns, despite their very similar morphology. Like in the above mentioned species, apparent changes in the fingerprint patterns are probably due to an insertion into the 18S rDNA gene. According to our results, the cultures from the Atlantic region showed a smaller (Cuba) or no insertion at all (LaPalma) in contrast to the cultures from the Indopacific regions (Papua New Guinea, Thailand), Guadeloupe and Texas. However, more data on strains of *D. eschscholzii* from different geographic locations (and the genomic constitution of *Daldinia* in general) should be generated to verify this observation. Furthermore, more work on the host range of *D. eschscholzii* should be carried out.

In accordance with results of HPLC analysis, the taxon treated herein as *D.* cf. *loculata* ss. Petrini and Müller and *D. childiae* formed a homogenous group with regard to their ARDRA patterns and can be distinguished from other species by this technique but not from one another. Most interestingly, the ARDRA pattern type C is typical for those taxa of *Daldinia* which show yellow KOH-extractable pigments, produce azaphilones and benzophenones in stromata and other specific metabolites in culture.

The ARDRA patterns of the yet unnamed *Daldinia* spp. from Scania and Russian Far East (Ju et al., 1999) were quite different, which was in accordance with their distinct secondary metabolite profiles in culture. Together with slight deviations in ascospore size and other morphological characteristics, these observations give reason to assume the presence of two distinct stipitate *Daldinia* spp. with purple stromatal pigments and morphological similarities to *D. cudonia*.

Most remarkably, a rather large amplification product of 2.8 kb was obtained in *D. loculata*. Consequently, rather unique ARDRA patterns were obtained with the examined strains. In accordance with other data (HPLC, morphology), *D. loculata* isolates from Europe and Russian Far East showed a consistent pattern, which is in accordance with Johannesson et al. (2000).

In species such as *D. childiae, D. concentrica* and *D. fissa*, consistent results were obtained for several cultures from different hosts. In contrast, our investigations of several other *Daldinia* spp. and allies so far is based only on data obtained with one or two strains. However, the ARDRA results are in accordance with the separation of *Biscogniauxia, Entoleuca, Kretzschmaria* and *Nemania* spp. from *Hypoxylon* as based on morphological grounds.

These findings show that genetic fingerprinting methods may prove useful to discriminate morphologically similar Xylariaceae species. These results should be refined by alternative techniques, possibly relying on other gene portions and methods. A recent DNA sequencing study on the ITS region in five taxa of *Daldinia* in Northern Europe (Johannesson et al., 2000) revealed high similarities between *D. grandis* and *D. loculata,* both of which significantly differed from *D. concentrica, Daldinia cf. fissa* and, most strongly, from a taxon named *Daldinia cf. petriniae.* We did not yet study the *D. grandis* and *Daldinia cf. fissa* reported by these authors. However, representative cultures of the *D. loculata, D. concentrica and D. petriniae* cultures obtained by Johannesson et al. were kindly provided to us for comparison. We found the morphology, secondary metabolism and ARDRA patterns in accordance with our own materials of these taxa. While ARDRA patterns of *D. loculata* showed strong deviations as compared to *D. concentrica* and *D. petriniae* as well, the differences in the ITS regions by between *D. concentrica* and *D. petriniae* reported by Johannesson et al. were not reflected by ARDRA. This suggests that only a simultaneous investigation, possibly including several gene portions and methods can provide a stable phylogenetic tree of *Daldinia* spp.

CONCLUSIONS AND OUTLOOK

In the present study, genetic fingerprints and HPLC-based secondary metabolite profiles were used for the first time to study the taxonomy of a broad range of *Daldinia* spp. and other xylariaceous fungi. Strong correlations were noted between secondary metabolite profiles and the taxonomically important colour of KOH-extractable stromatal pigments. PCR-based techniques proved helpful for discrimination of some taxa on both the genus and species level. In *Daldinia*, a combination of both genetic fingerprinting and secondary metabolite profiling seems appropriate for taxonomic purposes. Apart from the before mentioned studies of Whalley and Edwards (1995) on Xylariaceae, most work in this field has hitherto been done with Deuteromycetes (e.g. mycotoxin producers, phytopathogenic fungi; see overview in Frisvad et al., 1998). However, as recently demonstrated with *Aspergillus* section Candidi, by investigations of previously unplored fungal taxa may even yield novel secondary metabolites of taxonomic relevance (Rahbaek et al., 2000).

HPLC-MS was hardly ever employed before in chemotaxonomy, even though there are examples in the literature on the application of this methodology on the detection of secondary metabolites in crude extracts derived from plants and microbial organisms (Stadler et al., 1998; Julian et al., 1998) .Except from the investigation by Geiser et al. (1998) on *Aspergillus/Neosartorya*). Similar studies, combining PCR-based methods, metabolite patterns and morphological characters in fungal taxonomy, have so far been sparse.

Molecular genetics and secondary metabolite analyses are becoming increasingly important in applied research aiming at the discovery of new fungal metabolites with promising bioactivities and the concurrent characterisation of producer strains. HPLC-based secondary metabolite profiles and PCR techniques are already being combined for such purposes (Bills et al., 1999). Such techniques are probably going to find a broader application in the future, e.g., as admissible data in patents. Furthermore, secondary metabolites and genetic fingerprints might eventually constitute important markers and parameters in assessments of biological diversity of morphologically non-characterised strain collectives, e.g., of soil-inhabiting imperfect fungi. However, before this becomes feasible, much work remains to be done to combine the discriminatory power of these new techniques with the wealth of information provided by classical taxonomy.

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AMAZONIA GONIOTHALAMI SP. NOV. AND SOME ADDITIONAL RECORDS OF FUNGI ON GONIOTHALAMUS WIGHTII FROM INDIA

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Summary

An endemic plant, *Goniothalamus wightii,* was infected with four fungi. Of these, *Amazonia goniothalami* was found to be an undescribed species; *Trichasterina goniothalami* Hosag. & Goos is relocated here after its type locality. *Spiropes dorycarpus* (Mont.) M.B. Ellis and *S.guareicola* (Stev.) Cif. are the hyperparasites on these two fungi.

Key words *: Amazonia, Trichasterina*, Hyperparasites

Chemunji, a part of Southern Western Ghats, located towards the eastern side of Thiruvananthapuram district, Kerala and bordered by Tamil Nadu, harbours evergreen forest at an altitude of 1000 m. The forest was selected for the population study of *Goniothalamus wightii* Hook. f. & Thoms. (Annonaceae), a plant endemic to this region. This plant occurs in the subtropical evergreen forests at an altitude of 1000-1500 m. (Mitra, 1993). During this survey, around 30 plants with a height of 1.5 – 2.5 m. were located. Except for small seedlings, almost all plants in the study area were infected with black woolly colonies of fungi. About 75 % of the leaves and about 40 % of the leaf surface area were covered with these fungal colonies. Microscopic examination revealed two parasitic forms. Of these, *Amazonia goniothalami* is an undescribed species, while, *Trichasterina goniothalami* Hosag. & Goos has been previously reported on this host from the eastern side of the Western Ghats. Two hyperparsites (fungicolous fungi) were observed on these fungi and are reported here.

1. *Amazonia goniothalami* sp. nov. (Fig.-1)

Coloniae plerumque hypophyllae, subdensae vel densae, ad 5 mm diam., confluentes. Hyphae rectae, alternate vel opposite acutequ ramosae, laxe vel arte reticulatae, cellulis 9-16 x 6-8 μm. Appressoria alternata, antrorsa vel arte antrorsa, 18-26 µm longa; cellulae basalis cylidraceae vel cuneatae, 6-8 µm longae; cellulae apicalis ovatae, oblongae vel cylindraceae, integrae, 12-15 x 8-12 µm. Phialides non visa. Perithecia applanato-globosa, radiata, ad 160 µm diam.; ascosporae oblongae vel ellipsoideae, 4-septatae, constrictae, 44–48 x 20-23 µm.

Colonies predominently hypophyllous, subdense to dense, up to 5 mm in diameter, confluent. Hyphae straight, branching alternate to opposite at acute angles, loosely to closely reticulate, cells 9-16 x 6-8 µm. Appressoria alternate, antrorse to, closely antrorse, straight, 18-26 µm long; stalk cells cylindrical to cuneate 6-8µm long; head cells ovate, oblong to cylindrical, entire, 12-15 x 8-12 µm. Phialides not seen. Perithecia flattened-globose, radiating, up to 160 µm in diam.; ascospores oblong to ellipsoidal, 4- septate, constricted at the septa, 44 -48 x 20–23 µm.

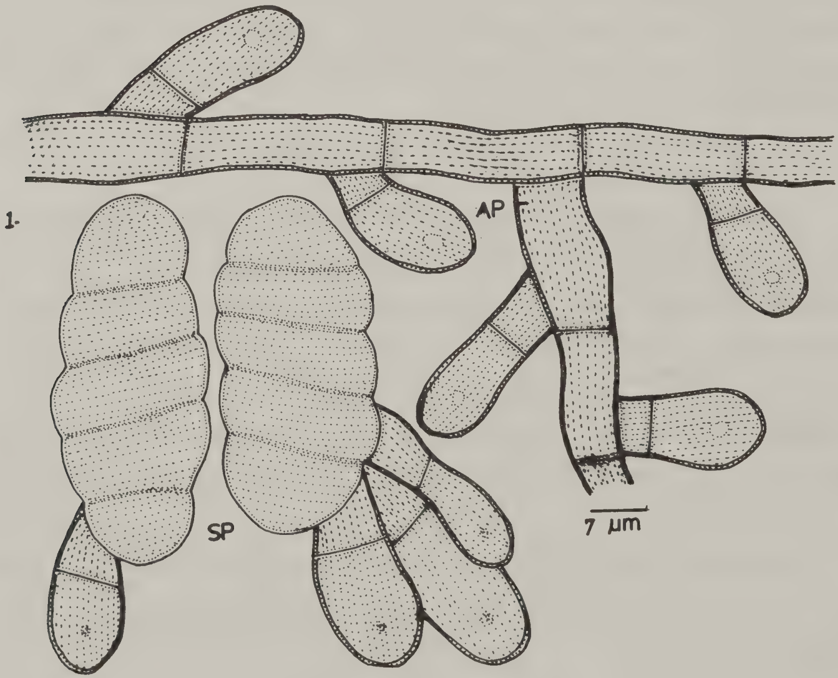

Fig. 1. *Amazonia goniothalami* sp. nov.

Abbreviations used: AP – Appressoria; SP- Ascospores

Holotype: On leaves of *Goniothalamus wightii* Hook.f. & Thoms. (Annonaceae), Chemunji, near Bonaccord, Thiruvananthapuram, Kerala, India Dec. 9,1999, G. Rajkumar HCIO (*p.p.*).

Isotype : TBGT 257 (*p.p.*)

This forms the first representation of the genus *Amazonia* on the members of the family Annonaceae (Hansford, 1961; Hosagoudar, 1996; Hosagoudar *et al.*, 1997) and hence, it is proposed here as a new species.

2. *Trichasterina goniothalami* Hosag. & Goos, Mycotaxon 59: 165, 1996.

On leaves of *Goniothalamus wightii* Hook. f. & Thoms. (Annonaceae), Chemunji, Bonaccord, Kerala, April 12, 1998, G. Rajkumar TBGT 258; April 23, 1998, G. Rajkumar TBGT 260; July 16, 1998, G. Rajkumar TBGT 261; Dec.8, 1998, G. Rajkumar TBGT 259.

This species was collected on the same host from the eastern side of Western Ghats in Tamil Nadu (Hosagoudar & Goos, 1996). It was known only from the type and now, its distribution is extended to the western side of Western Ghats in Kerala.

3. *Spiropes dorycarpus* (Mont.) M.B. Ellis , Mycol. Pap. 114: 11,1968; Ellis, Dematiaceous Hyphomycetes, p. 253, 1977.

Overgrowing colonies of *Amazonia goniothalami* sp.nov. and *Trichasterina goniothalami* Hosag. & Goos. On the former fungus, it completely masks and jeopardises the identity of the host fungus even up to group level.

4. *Spiropes guareicola* (Stev.) Cif. Sydowia 9:303, 1955; Ellis, Dematiaceous Hyphomycetes, p. 950, 1977.

Overgrowing on the colonies of *Amazonia goniothalami* sp.nov. and *Trichasterina goniothalami* Hosag. & Goos.

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STUDIES IN TROPICAL AFRICAN LACTARIUS SPECIES.
10. INFRAGENERIC CLASSIFICATION

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ABSTRACT

An infrageneric classification is proposed for 80 tropical African *Lactarius* species. Those are classified in 5 subgenera and 18 sections, including one new subgenus, *Russulopsis*, and 7 new sections: *Afrobarbati*, *Amari*, *Aurantiifolii*, *Chromospermi*, *Pulchrispermi, Russuliformes* and *Russulopsidei*. Most of the sections are classified within the existing subgenera, but the systematic position of some other sections, as well as a small number of insufficiently known species, needs further studies. Only two sections, *Rugati* and *Plinthogali*, are also represented outside tropical regions.

KEYWORDS: Lactariopsis, Lactiflui, Plinthogali, Piperites, Russulopsis

INTRODUCTION

Until recently taxonomical knowledge of tropical African milkcaps was almost confined to the studies of Heim (1938, 1955). Heim studied only a limited number of African *Lactarius* species and classified them in provisional, mostly invalidly described groups. For some years, new studies made clear that many of these *Lactarius* species do not fit in the modern classification systems for this genus defined by Basso (1999), Heilmann-Clausen et al. (1998), Hesler & Smith (1979) and Singer (1986). This is not surprising as, except for Singer's classification, these systems do not include tropical taxa. At present, about 85 accepted taxa are known from tropical Africa, all of them endemic for the continent. Many of them show a number of features not encountered in more temperate regions, and therefore, are classified in new infrageneric taxa.

PRACTICAL KEY TO SECTIONS

1. Stipe with a distinct, more or less fugaceous annulus (Fig. 1) .... sect. *Lactariopsis* & *Lactarius indusiatus*
   Stipe without an annulus 2

2. Context blackening 3
   Context not blackening (browning, unchanging etc.) 4

3. Hymenium without lamprocystidia. Spores with winged ornamentation, at least 1 µm high .... sect. *Nigrescentes*
Hymenium with lamprocystida (Fig. 2). Spores ornamented with low warts or ridges .... sect. *Rubroviolascentini*

4. Spore print chocolate brown........ sect. *Chromospermi*
Spore print white to yellowish or pale pinkish, at most pale brown 5

5. Pileus pale, viscid and hirsute with tomentose margin .... sect. *Afrobarbati*
Pileus without tomentose margin 6

6. Latex and bruised context changing brown, smell usually fishy, spores with isolated warts (Fig. 3) .... sect. *Phlebonemi*
Not with this combination of characters........ 7

7. Pileus pruinose, orange and concentrically zonate when moist. Lamellae-edge fimbriate, appendiculate, with transparent dropplets when fresh; stipe tapering downwards and clearly chambered (Fig. 4) .... sect. *Aurantiifolii*
Not with this combination of characters........ 8

8. Carpophores rather small. Pileus ochraceous, concentrically zonate when fresh, stipe fistulous........ sect. *Amari*
Not with this combination of characters........ 9

9. Basidiomes reminding of a small, reddish or pinkish Russula. Stipe often finely punctate, concolorous with cap .... sect. *Russuliformes*
Not with this combination of characters........ 10

10. Pileus dry and velvety, sometimes wrinkled or cracked, never sticky or viscid; pileipellisstructure a palisade or hymeniderm 11
Pileus usually smooth, viscid or not; pileipellisstructure no distinct palisade or hymeniderm........ 15

11. Pileus and stipe dull coloured (greyish, brown, buff). Spores often winged or reticulate; plage distally amyloid (Fig. 5) ....sect. *Plinthogali*
Spores ornamented with lower warts and ridges, never winged; if plage amyloid, then with a central spot........ 12

12. Hymenium with conspicous lamprocystidia (Fig. 2) .... sect. *Pseudogymnocarpi*
Hymenium without lamprocystidia........ 13

13. Pileus often conspicuously wrinkled; pileipellis with distinctly thick-walled, sometimes very irregularly shaped elements, suprapellis thicker than the subpellis; context often greenish with $FeSO_4$........ sect. *Gymnocarpi*
Pileus sometimes wrinckled; elements in the pileipellis thin-walled or only slightly thick-walled, cylindrical and regular; subpellis thicker than the suprapellis or no

clear distinction between subpellis and suprapellis; context pinkish or unchanging with $FeSO_4$ 14

14. Pileipellis a distinct palisade with a thick and regular subpellis composed of compact sphaerical cells; context pinkish with $FeSO_4$.......... section *Rugati*
    Pileipellis never a regular palisade, composed of chains of subcylindrical to subsphaerical cells (cap often crackled); context pinkish or unchanging with $FeSO_4$ .... section *Edules*

15. Spores rather lowly ornamented with warts and short ridges, sometimes connected with fine lines 16
    Spores highly ornamented (ornamentation up to 2 µm or higher) with distinct wings 18

16. Pileomacrocystidia present (Fig. 6); pileus often with reddish colours .... sect. *Russulopsidei*
    Pileomacrocystidia absent, sometimes hair-shaped thick-walled elements in the pileipellis; pileus often with yellowish, orange or brownish colours 17

17. Pileus shiny and smooth, margin distinctly striate or sulcate; pileipellis most often with scattered thick-walled hairs .... sect. *Chamaeleontini* & *L. pruinatus*
    Pileus rather dry, never with striate or sulcate margin; no thick-walled hairs in the pileipellis .... sect. *Edules*

18. Pileocystidia present; pileus pruinose .... sect. *Pulchrispermi*
    Pileocystidia absent; pileus smooth, sometimes shiny or subviscid .... sect. *Pseudofuliginosi*

INFRAGENERIC CLASSIFICATION

1. Subgenus **LACTARIOPSIS** (Henn.) R. Heim, Prodr. Fl. Mycologique Madagascar 1 (1938) 36, type = *L. zenkeri* (Henn.) Singer
   prov. not classified species: *L. indusiatus, L. pruinatus.*

   1.1. Section **Lactariopsis** (Henn.) Singer, Ann. Mycol 40 (1942) 111 (ut "Lactariopsideae"), type = *L. zenkeri* (Henn.) Singer
   syn.: Section *Lactariopsidei* "Singer ex" Singer, Sydowia 15 (1962) 83, type = *L. zenkeri*, illegit.
   species: *L. annulatoangustifolius, L. heimii, L. pelliculatus, L. velutissimus, L. zenkeri.*

   1.2. Section **Chamaeleontini** Verbeken, Mycotaxon 66 (1998) 393, type = *L. chamaeleontinus* R. Heim
   species: *L. chamaeleontinus, L. emergens, L. laevigatus, L. sesemotani.*

2. Subgenus **LACTIFLUI** (Burl.) Hesler & A.H. Sm., North Amer. Species Lactarius (1979) 158 (ut "Lactifluus" et "type = L. volemus"), type = *L. lactifluus* (L.) Quél.

2.1. Section **Phlebonemi** R. Heim ex Verbeken, Mycotaxon 66 (1998) 378, type = *L. phlebonemus* R. Heim & Gooss.-Font.
species: *L. angustus, L. arsenei, L. brunnescens, L. caperatus, L. nonpiscis, L. phlebonemus, L. pisciodorus.*

2.2. Section **Rugati** (Pacioni & Lalli) Verbeken, Mycotaxon 66 (1998) 372, type: *L. rugatus Kühner & Romagn.*
species: *L. kivuensis, L. pseudovolemus, L. rubiginosus, L. volemoides.*

2.3. Section **Gymnocarpi** R. Heim ex Verbeken, Mycotaxon 66 (1998) 374, type = *L. gymnocarpus* R. Heim ex Singer
species: *L. albocinctus, L.. flammans, L. goossensiae, L. gymnocarpus, L. tanzanicus.*

2.4. Section **Pseudogymnocarpi** Verbeken, Mycotaxon 66 (1998) 376, type = *L. gymnocarpoides* Verbeken
species: *L. carmineus, L. gymnocarpoides, L. longisporus, L. luteopus, L. medusae, L. pseudogymnocarpus, L. pumilus.*

2.5. Section **Rubroviolascentini** (Singer) Verbeken, Mycotaxon 66 (1998) 380 (ut "Rubroviolascentes"), type = *L. rubroviolascens* R. Heim.
basionym: subsection *Rubroviolascentini* Singer 1942, Ann. Mycol. 40 (1942) 114
species: *L. rubroviolascens*, *L. denigricans.*

(1) *Lactarius denigricans* Verbeken & Karhula seems closer related to the section *Pseudogymnocarpi* than *L. rubroviolascens* (pileipellis a regular palisade, spores with a centrally amyloid plage) and therefore formerly was classified in this section (Verbeken 1998a). I prefer now to classify it close to *Lactarius rubroviolascens* because of the remarkable colour change of latex and context, the main character of this section. The inclusion of *L. denigricans* makes the definition of the section somewhat broader because this species lacks the elements with globose and swollen apex at the base of the stipe, and because the presence of an amyloid plage.

3. Subgenus **PLINTHOGALI** (Burl.) Hesler & A.H. Sm., North Amer. Species Lactarius (1979) 99, (ut "Plinthogalus" & "type = L. lignyotus"), type = *L. plinthogalus* (J. Otto) Burl.

3.1. Section **Plinthogali** (Burl.) Singer, **s.l.**, Ann. Mycol. 40 (1942) 123, type = *L. plinthogalus* (J. Otto) Burl.
species: *L. acutus, L. adhaerens, L. congolensis, L. kabansus, L. kalospermus, L. melanodermus, L. nudus, L. pseudolignyotus, L. pusillisporus, L. rumongensis, L. saponaceus, L. sulcatulus, L. sulcatus, L. tenellus.*

3.2. Section **Nigrescentes** Verbeken, Persoonia 17 (2000) in print, type = *L. melanogalus* R. Heim ex R. Heim
species: *L. baliophaeus, L. griseogalus, L. melanogalus, L. orientalis.*

3.3. Section **Pseudofuliginosi** Verbeken, Persoonia 17 (2000) in print, type = *L. atroolivinus* Verbeken & Walleyn
species: *L. atroolivinus, L. undulatus, L. undulatus var. rasilis.*

4. Subgenus **PIPERITES** (Fr. ex J. Kickx f.) Kauffman, Agaricaceae of Michigan: 88 (1918), type = *L. torminosus* (Schaeff.: Fr.) Pers.

4.1. Section **Afrobarbati** Verbeken, **sect. nov**., *pileus viscosus, hirsutus, pallidus, margine involuto, tomentoso; latex albus, gustu mitis; sporae ellipsoideae, amyloideae, reticulatae; macrocystidia absentia; pileipellis cutis ad ixocutis, ex hyphis parallelibus, longis, 2-5 µm diam.*; typus = *Lactarius barbatus* Verbeken.
species: *L. barbatus.*

(1) The pale, subviscid tomentose pileus with an involute hairy margin, and the white latex of *Lactarius barbatus* remind of the European species of section *Piperites* (Quél.) Burl. *Lactarius barbatus* differs from the known representatives of this section by the mild latex, the spore ornamentation consisting of high ridges forming a coarse and regular reticulum and the absence of macrocystidia.

4.2. Section **Chromospermi** Verbeken, **sect nov**., *pileus siccus vel sebosus, pallidus; lamellae in maturitato brunneae, chocolatinae. Context albidus. Latex albus, flavescens in sicco. Sporae brunneae, chocolatinae in cumulo, ellipsoideae, ornatae irregulare reticulatae. Pleurocystidia abundantia. Pileipellis cutis ad ixocutis, pileocystidia presentia*; typus = *L. chromospermus* Pegler.
species: *L. chromospermus.*

(1) Pegler (1983) included *Lactarius chromospermus* in the subsect. *Lactiflui* (Burl.) Singer [within the invalidly described sect. *Dulces* (R. Heim) Singer] because of inferred relationships with *Lactarius volemus* (Fr.: Fr.) Fr. This relationship is unclear to me as the two species have very different types of cystidia and pileipellis. When comparing the characters of *Lactarius chromospermus* with other *Lactarii* (Buyck & Verbeken 1995), most resemblances are found with species such as *L. pallidus* (Pers.: Fr.) Fr. or *L. trivialis* (Fr.: Fr.) Fr. belonging to the sect. *Triviales* Hesler & A.H. Sm.. Representatives of this section however have a much paler spore-print and a more pronounced ixocutis. The exceptional dark brown spore-print of *Lactarius chromospermus* and the presence of pileal cystidia argue in favour of placing this species in a monotypic section of *Lactarius* subgenus *Piperites.*

5. Subgenus **RUSSULOPSIS** Verbeken, **subg. nov**., *pileus laevis ad leviter tomentosus, vivide coloratus. Pleurocystidia si presentia nunc pariete leviter incrassato et contento*

aciformi. Pileipellis cutis, pileocystidia presentia, abundantia; typus = *L. ruvubuensis* Verbeken.

5.1. Section **Russulopsidei** Verbeken, **sect. nov**., *pileus laevis ad leviter tomentosus, vivide coloratus, aurantiacus vel rubidus. Latex albus, interdum virescens, grisescens vel brunnescens in sicco. Pileocystidia si presentia nunc pariete leviter incrassato et contento aciformi. Pseudopleurocystidia abundantia, emergentia, irregularia, spiraliformia, tortuosa, digitiformia. Pileipellis cutis, pileocystidia presentia, abundantia*; typus = *L. ruvubuensis* Verbeken.
species: *L. brachystegiae, L. claricolor, L. corbula, L. cyanovirescens, L. longipes, L. pseudotorminosus, L. ruvubuensis, L. urens.*

(1) This subgenus gathers several species, provisionally classified in one section, which show in several cases some macroscopical characters typical for *Russula*: scarce latex, chambered stipe and partly dehiscent pileipellis. Microscopically, the pileipellisstructure with abundant macrocystidia is very uncommon in *Lactarius* and reminds also of *Russula*. In the temperate regions, such cystidia (with capitate apex, guttate or needle-like content and sometimes slightly thickened walls) are only known for *Lactarius piperatus* (subgenus *Lactarius*). The most russuloid species is *Lactarius ruvubuensis* Verbeken, where some basidiomes have a hymenophoral trama without lactifers and pleuropseudocystidia, completely composed of sphaerocytes. In other basidiomes, however, pleuropseudocystidia have been traced, and in the field they exudate abundant white latex. Basidiomes lacking pseudocystidia had more true pleurocystida, with similar size and shape as the pseudocystida but they are not connected with lacticiferous hyphae, although they arise very deep in the hymenium.

(2) Provisionally some small groups could be recognised:
- with orange cap: *L. brachystegiae, L. pseudotorminosus*;
- with pale, sulcate cap: *L. corbula, L. claricolor*;
- with reddish or reddish brown cap: *L. cyanovirescens, L. ruvubuensis, L. longipes, L. urens*.

(3) Heim (1938, 1955) classified these species in different sections: *Lactarius pseudotorminosus* in the *Velutini* (Quél) Bat., *L. claricolor* in the *Laevini* R. Heim (invalid), *Lactarius corbula* in the *Ingrati* R. Heim. He stated that the latter species reminds of species of *Russula* subsect. *Foetentinae* (same grooved pileus-margin and similar pleurocystidia arising deep in the subhymenium or trama).

0. Not classified at subgenus level

0.0. Provisionally unclassified, insufficiently known species: *L. badius, L. fulgens, L. hispidulus, L. striatus*.

0.1. Section **Edules** Verbeken in Verbeken & Walleyn, Belg. J. Bot. 132: 176 (2000), type = *Lactarius edulis* Verbeken & Buyck.
species: *L. aureifolius, L. densifolius, L. edulis, L. inversus, L. latifolius, L. phlebophyllus*.

(1) The taxonomic position of this section is discussed in Verbeken & Walleyn (2000).

0.2. Section **Amari** Verbeken **sect. nov.,** *pileus laevis, siccus, concentrice zonatus. Lamellae liberae vel decurrentes, vivide coloratae. Latex albus. Sporae amyloideae, incomplete vel subcomplete reticulatae, cristis usque ad 1(1.5) µm altis; macula suprahilaris, distale amyloidea. Macrocystidia absentia. Pileipellis cutis ad trichoderma, ex hyphis longis, irregulare intermixtis*; typus = *L. subamarus* Verbeken.
species: *L. amarus, L. subamarus.*

(1) Both species are characterized by the trichoderm-like structure of the pileipellis which is composed of very long and interwoven hyphae. This character, together with the bright colour, the zonate aspect and the rather heavily ornamented spores makes them outstanding and hard to classify in any of the known subgenera.

0.3. Section **Aurantiifolii** Verbeken **sect. nov.,** *pileus leviter velutinus ad pruinosus, vivide coloratus, concentrice zonatus. Lamellae coloratae, acies pallidior, pendiculata. Latex albidus. Sporae albae in cumulo, irregulariter verrucosae ad incomplete reticulatae. Macropleurocystidia presentia, clavata, pariete leviter incrassato. Pileipellis trichoderma*; typus = *L. aurantiifolius* Verbeken.
species: *L. aurantiifolius*

(1) *Lactarius aurantiifolius* has some characters in common with species of the subgenus *Lactarius* s.str.: same type of macrocystidia, spore ornamentation, chambered tapering stipe. The zonate pileus which has a trichoderm-structure and the mild taste of the context are important differences. The trichoderm-structure of the pileus is a character present in other groups such as section *Albati* (but with thick-walled elements!), section *Colorati* or section *Edules*. But this species is aberrant and the classification in one of these groups unsatisfying. A particular feature, not encountered in any other *Lactarius* species is the strongly fimbriate, appendiculate lamella-edge, which is often covered with watery tears.

0.4. Section **Russuliformes** Verbeken **sect. nov.,** *pileus tenellus, nanus, pallide aurantia ad rosea, brunneorosea. Lamellae albidae ad cremeae. Latex albidus. Sporae albae in cumulo, verrucis sublaevibus vel altis, interdum connexis ornatae. Macropleurocystidia absentia. Pileipellis hymeniderma*; typus = *L. roseolus* Verbeken.
species: *L. roseolus, L. russuliformis.*

(1) In the field these species look like a *Russula* and have in no way the classic habit of a *Lactarius*, but they exudate abundant latex when bruised and have numerous pseudocystidia. *Lactarius roseolus* shares the low ornamented spores and the elements of the pileipellis and the sphaerocytes in the hymenophoral trama with *Russula parvorosea* Buyck, a member of *Russula* subsection *Parvoroseinae* Buyck, which encompasses small, thin-fleshy *Russula* species with pinkish stipe and pileus. True cystidia however are present in the *Parvoroseinae* and absent in *Lactarius roseolus*. *L. russuliformis* (Beeli) Verbeken has a very different spore

ornamentation, consisting of long and acute spines – typical for the genus *Russula* - which are connected by fine lines (Verbeken 1996a). *Russula sese* Beeli, also included in the subsection *Parvoroseinae*, has also a higher spore ornamentation, totally different from the one in *R. parvorosea*. Further research should point out whether both *Lactarius roseolus* (typical *Lactarius* spores) and *L. russuliformis* (typical *Russula*-spores) form a natural group with close affinities to *Russula* subsection *Parvoroseinae* [*Russula parvorosea* (typical *Lactarius*-spores) and *R. sese* (typical *Russula* spores)]. *Lactarius liliputianus* Verbeken & Horak from South East Asia probably also belongs here.

0.5. Section **Pulchrispermi** Verbeken **sect. nov.** , *pileus valde infundibuliformis, margine crenulato striato, velutinus ad subtiliter squammulosus. Latex albus, leviter brunnescens. Sporae subglobosae, cristis altis ornatae, zebroideae. Pleurocystidia presentia. Pileipellis cutis, pileocystidia abundantia*; typus = *L. pulchrispermus* Verbeken.

(1) The only known representative of this section, *Lactarius pulchrispermus*, is characterized by a particular combination of characters: distinctly zebroid spores, abundant corkscrew-like pleuropseudocystidia and very abundant macrocystidia which are often slightly thick-walled, have a distinct needle-like content and occur in the hymenium as well as in pilei- and stipitipellis. The species shows some affinity with the representatives of the subgenus *Russulopsis* by the remarkable cystidia, but in *L. pulchrispermus* the pileus is dull coloured and felty, being a trichoderm-like structure instead of a cutis.

DISCUSSION

Main characters used here for classification are the structure of the pileipellis (incl. presence of thick-walled elements, pileocystidia),which is related to the macroscopic aspect of the pileus, the type of true pleurocystidia (macrocystidia, lamprocystidia) and the colour reactions of latex and context. Whereas some subgenera and sections are very well-represented in tropical Africa (e.g. subgenera *Lactiflui* and *Plinthogali*), an important number of sections is until now monotypic. Most of the sections are classified within the existing subgenera but the systematic position of some other sections remains unclear. This classification system proposed here is partly provisional and practical, but wants to present some new insights in relations between species since other classification systems based on tropical species (Heim, Singer) are to be abandoned. The discovery of new species in tropical Africa and other tropical regions, and the acquaintance of molecular data, can guarantee a better and more complete classification system in the future.

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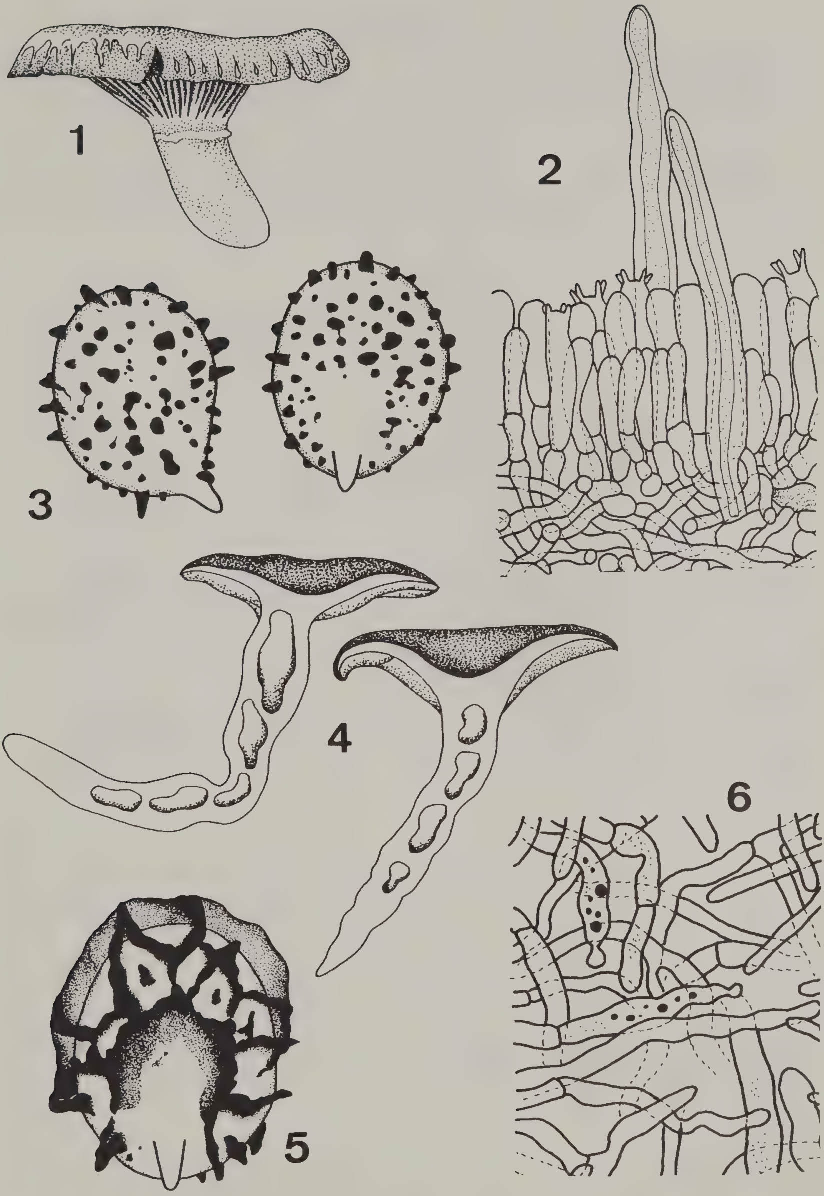

Figs. 1. Annulated stipe. 2. Lamprocystidia in the hymenium. 3. Spores with isolated warts (section Phlebonemi). 4. Chambered stipe. 5. Plage distally amyloid. 6. Pileomacrocystidia.

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HYPOCENOMYCE OLIGOSPORA AND H. SIERRAE, TWO NEW LICHEN SPECIES

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ABSTRACT: The new species *Hypocenomyce oligospora* and *H. sierrae* are described from North America; the former is widely distributed and also reported from Siberia, the latter is restricted to the mountains of southern California and Arizona. Both species are corticolous and lignicolous on conifers, often growing on charred substrates. They are closely related, differing mainly in the presence or absence of soredia. The species bridge the *H. friesii*- and *H. scalaris*-groups, and also show similarities with the *H. xanthococca*-group.

KEYWORDS: Lecanorales, taxonomy, North America, conifers, charred wood and bark.

Introduction

The lichen genus *Hypocenomyce* M. Choisy (Lecanorales) was revised by Timdal (1984) who accepted 10 species in four groups: the *H. anthracophila*-, *H. friesii*-, *H. scalaris*-, and *H. xanthococca*-groups. Two species have subsequently been described: *H. stoechadiana* Abassi & Cl. Roux (Abassi Maaf & Roux 1984) and *H. leucococca* R. Sant. (Santesson in Moberg 1986). The former species was later included in *Waynea* Moberg by Roux & Clerc (1991); the latter fits the *H. xanthococca*-group chemically (alectorialic acid): its ascocarp is unknown. During taxonomic studies for the Greater Sonoran Desert Lichen Flora project, I have discovered the two new species described below.

Material and Methods

This study is based on examination of all relevant material in ASU, MIN and O; selected specimens in COLO and the private herbaria of Trevor Goward and Bruce D. Ryan; and on material collected by myself on field trips in southwestern U.S.A. and northwestern Mexico in 1994, 1998, and 1999, in part arranged by the Greater Sonoran

Desert Lichen Flora project. A total of about 450 North American specimens of *Hypocenomyce* have been examined, among which 91 were of the two new species.

Thin-layer chromatography, in accordance with the methods of Culberson (1972), modified by Menlove (1974) and Culberson & Johnson (1982), was performed on 89 specimens of the two new species. Iodine reactions were observed in a modified Lugol's solution (water replaced by 50% lactic acid) after pretreatment with 10% KOH. The N-reaction refers to the reaction with 50% HNO_3.

Hypocenomyce oligospora Timdal, **sp. nov.** Fig. 1A

Species *H. friesio* similis, sed ascis vulgo immaturis, pycnosporis bacilliformibus, et acidum alectorialicum vel acidum thamnolicum continens.

Type: U.S.A., Arizona, Gila Co., Little Diamond Rim above Beaver Valley, 34°20'30"N, 111°18'30"W, alt. 1840 m, piñon-juniper woodland, on burned *Juniperus* wood, 1999.03.14, T.H. Nash III No. 42735a, (O, holotype; isotypes distributed in *Nash, Lich. Exs. ASU* No. 311).

Thallus squamulose; squamules up to 1.0 mm diam., adnate or irregularly ascending, concave, plane or convex, not sorediate; upper surface grayish green to dark brown, dull or shiny; margin entire, crenulate or incised, not upturned, concolorous with upper side. *Upper cortex* up to 30 μm thick, composed of thin-walled hyphae. *Apothecia* numerous, up to 1.0 mm diam., marginal or laminal, plane, black, epruinose, egyrose; margin remaining prominent, entire or flexuose; exciple composed of closely conglutinated hyphae, olivaceous in inner part, brownish black in the rim, not containing crystals, K+ brown, N– or N+ violet; hypothecium dark brown; epihymenium dark brown, not containing crystals, K+ brown, N–; paraphyses without swelling or pigment cap in apical cell; ascus with a thin, evenly amyloid tholus and covered by an amyloid cap (but usually immature). *Ascospores* rare, ellipsoid, simple, 6–8 × 3–4 μm. *Pycnidia* sessile, attached to the margin of the squamules; pycnidial wall brown, K–, N–. *Pycnospores* bacilliform, 7–9 × c. 1 μm.

Chemistry: Alectorialic acid and thamnolic acid (n=45), alectorialic acid only (n=10), or thamnolic acid only (n=3); upper cortex PD+ yellow, K+ yellow, C+ red (rarely C–), KC+ red (rarely KC–).

Ecology and distribution: The species grows on bark and wood of conifers, often charred, in conifer forests. The Russian material was collected from charred wood of *Larix gmelinii* in open *Larix* forest at c. 450–600 m alt. The specimen from Alaska grew on charred wood at 440 m alt. The specimen from British Columbia grew in open *Pinus contorta* forest at 1400 m alt., and specimens from Wyoming, Colorado, South Dakota, Minnesota and Michigan were collected from various conifer forests at 1370 to 2560 m alt. In Arizona and Chihuahua, recorded habitats include pinyon-juniper woodland, oak-pine forest, ponderosa pine forest, Douglas fir-pine forest and spruce-fir forest; with altitude ranging from 1720 to 2950 m.

Discussion: The species is morphologically similar to *H. friesii* (Ach.) P. James & Gotth. Schneid., and can hardly be recognized without chemical or anatomical studies. It differs in forming almost exclusively immature asci with no apical apparatus or spores, having

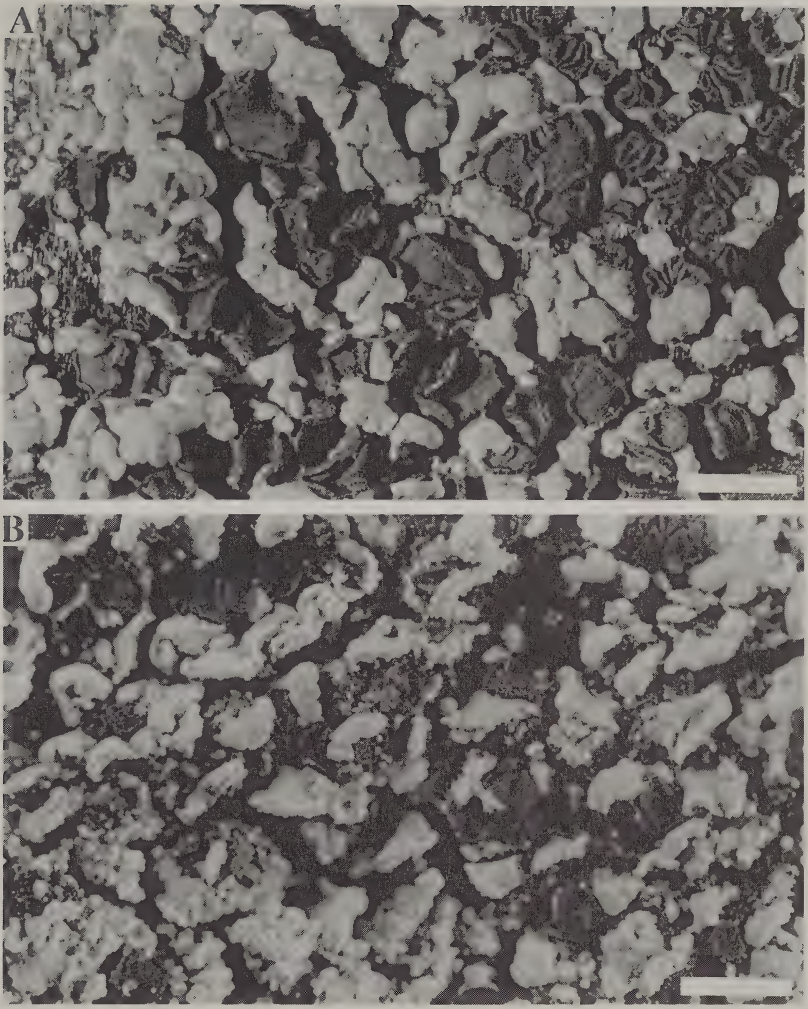

Fig. 1. A: *Hypocenomyce oligospora*, U.S.A., Arizona, Timdal US212/1 (O); B: *H. sierrae*, U.S.A., California, Rui & Timdal US249/1 (O). Scale bar = 1 mm.

bacilliform pycnospores, and in the secondary chemistry (alectorialic and/or thamnolic acid). In *H. friesii*, asci with apical apparatus and spores are common; the pycnospores are narrowly ellipsoid to shortly bacilliform, 2.5–5 × c. 1 μm; and the thallus contains an unknown compound (PD–, K–, C–, KC–, UV+) (Timdal 1984). The apothecial disc is frequently gyrose in *H. friesii*, but always smooth in *H. oligospora*.

Although apothecia are normally numerous in this species, mature asci have been studied in only one specimen (Rui & Timdal US272/1). The tholus is thinner and without an axial body, but otherwise conforming to the ascus type occurring in *H. friesii* (type 2 of Timdal 1984).

Specimens examined: **Russia**, YAKUTIA, *Ojmyakonskii region*: c. 9 km SW of Ust'-Nera, 64°30'N, 143°10'E, alt. 530–680 m, 1992, Haugan & Timdal YAK04/5 (O); – along the river Indigirka, 54 km N-NNW of Ust'-Nera, 65°03'N, 143°09'E, alt. 450–480 m, 1992, Haugan & Timdal YAK09/11 (O). **Canada**, BRITISH COLUMBIA: Chilcotin Plateau, 5 km ENE of Mt Satah, 52°28'N, 124°39'W, alt. 1400 m, 1995, Goward, Miège & Iverson 95-1473B (hb Goward). **U.S.A.**, ALASKA: 10 mi N of Glenallen along the Richardson Hwy (Rt 4), 62°15'N, 145°26'W, alt. 440 m, 1977, Moser & Nash 16813 (ASU); – ARIZONA, *Apache Co.*: Fort Apache Reservation, adjacent Pacheta Creek at Maverick, alt. 7900 ft, 1975, Nash 10595 (ASU); – Apache Nat. Forest, Mt Baldy Wilderness area, trail from Phelp's cabin along east fork of the Little Colorado River, 33°50'N, 109°31'W, alt. 2950 m, 1990, Ryan & Nash 26837 (ASU); – Mt Baldy Wilderness, along trail from Phelp's Cabin towards Mt Baldy, 33°56'N, 109°30'W, alt. 2900 m, 1999, Rui & Timdal US272/1 (O); – *Cochise Co.*: Chiricahua Mts, on trail to Silver Peak and Headquarters Gulch, NE of Southwestern Research Station, alt. 6000–7000 ft, 1960, Weber, Shushan & Anderson S24654 (COLO, MIN); – Chiricahua Mts, Pole Bridge Canyon, 31°52'N, 109°20'W, alt. 1900–2100 m, 1979, Sigal, Link & Nash 15693 (ASU); – Chiricahua Mts, lower portion of Morse Canyon, 31°51'N, 109°19.5'W, alt. 2200 m, 1983, Nash 20990 (ASU, MIN); – Chiricahua Mts, Coronado Nat. Forest, vicinity of Sycamore campground along Turkey Creek, 31°51.8'N, 109°20.3'W, alt. 1940 m, 1995, Nash 37125 (ASU, MIN); – *Coconino Co.*: Grand Canyon Nat. Park, South Rim, on Rowes Well Road near edge of park, alt. 7000 ft, 1966, Wetmore 14992 (MIN); – Hackett Meadow on NE side of the San Francisco Peaks, alt. 8600 ft, 1974, Nash 10806 (ASU); – near East Lake on the Kaibab Plateau N of the Grand Canyon, ca. 17 km S of Jacob Lake, 36°34'N, 112°04'W, alt. 2620 m, 1983, Nash 21104 (ASU); – Mogollon Rim, overlooking Calf Pen Canyon, 34°26.5'N, 111°30.0'W, alt. 2030 m, 1999, Timdal US212/1 (O); – along Stoneman Lake Rd, ca 1 km W of Lake Mary Rd, 34°47.4'N, 111°27.5'W, alt. 2160 m, 1999, Rui & Timdal US215/1 (O); – along Rte 180 ca. 20 km (air) NW of Flagstaff, 35°19.8'N, 111°46.7'W, alt. 2430 m, 1999, Rui & Timdal US245/2 (O); – *Gila Co.*: N to NE side of Four Peaks near the Maricopa County line, 33°40'N, 111°18'W, alt. 2150 m, 1988, Nash 25384 (ASU, MIN); – top of the trail along the South Fork of Parker Creek, above Sierra Ancha station, 33°48'N, 110°58'W, alt. 2000 m, 1989, Nash 26408 (ASU); – Little Diamond Rim above Beaver Valley, 34°20.5'N, 111°18.5'W, alt. 1840 m, 1999, Nash 42735A (ASU, O, type collection); – *Graham Co.*: Pinaleno Mts, Goudy Canyon Research Area, 32°42'N, 109°56'W, alt. 2400–2800 m, 1979, Link & Nash 16621 (ASU); – *Mohave Co.*: Mt Hualapai, 35°05.9'N, 113°52.9'W, alt. 1960 m, 1999, Rui & Timdal US209/1 (O); – *Pima Co.*: Santa Catalina Mts, Coronado Nat. Forest, Aspen Loop Trail, 32°25'N, 511°45.5'W, alt. 2380 m, 1977, Nash 38962 (ASU); – Saguaro Nat. Mon., Rincon Mt Section, Reef Rock, alt. 8200 ft, 1986, Wetmore 54384 (MIN); – Saguaro Nat. Mon., Rincon Mt Section, NW side of Mica Mtn, alt. 8600 ft, 1986, Wetmore 54428 (MIN); – Saguaro Nat. Mon., Rincon Mt Section, N of Spud Rock in upper Joaquin Canyon, alt. 8000 ft, 1986, Wetmore 54480 (MIN); – Saguaro Nat. Mon., Rincon Mt Section, below Manning Camp, alt. 7800 ft, 1986, Wetmore 54573 (MIN); – Saguaro Nat. Mon., Rincon Mt Section, Devil's Bathtub Spring, alt. 7300 ft, 1986, Wetmore 54781 (MIN); – Saguaro Nat. Mon., Rincon Mt Section, W of Mica Meadow, N of Duckbill, alt. 8000 ft, 1986, Wetmore 54803 (MIN); – Santa Catalina Mtns, Bear Canyon Picnic Ground, 32°22'N, 110°42'W, alt. 1720 m, 1999, Rui & Timdal US202/4 (O); – *Santa Cruz Co.*: Santa Rita Mts, 1943, Darrow 1675 (ASU); – COLORADO, *Douglas Co.*: along Rampart Range Road, 12 km SE of jct. with Jackson Creek Road, alt. 2560 m, 1973, Anderson & Carmer 8344 (ASU); – Rampart Range Road, 7.0 mi S of jct. with Jackson Creek Road, Pike Nat. Forest, alt. 8400 ft, 1973, Carmer & Anderson 395 (ASU); – *Jefferson Co.*: along US6 14 mi E of Idaho Springs in Clear Creek Canyon W of Denver, alt. 6300 ft, 1967, Wetmore 16298 (MIN); – MICHIGAN, *Keweenaw Co.*: Isle Royale Nat. Park, inside Chippewa Harbour on N side of inner narrows, 1983, Wetmore 47117 (MIN); – Isle Royale Nat. Park, around old Feldtman lookout tower, 1983, Wetmore 48508 (MIN); – MINNESOTA, *Becker Co.*: near Missouri Lake, near SW corner of Itasca State Park, around tamarack swamp and in hardwoods at margin, 1974, Wetmore 23837 (MIN); – *Beltrami Co.*: 5 mi W of Bemidji along county hwy 14, 1974, Wetmore 23343B (MIN); – *Clearwater Co.*: N of Itasca State Park near hwy 200 W of Itasca Post Office 1.6 miles, 1972, Wetmore 20802 (MIN); – *Cook Co.*: near Wampus Lake, W of Trout Lake about 25 mi N of Grand Marais on Gunflint Trail, 1969, Wetmore 18593B (MIN); – *Lake Co.*: near Heart Lake, 13 mi SE of Ely, 1977, Wetmore 26828 (MIN); – along Caribou River in Caribou Falls State Park (16 mi NE of Silver Bay), 1978, Wetmore 36219 (MIN); – *St. Louis Co.*: red pine plantation 25–30 years old 8 mi S of Hoyt Lakes, 1977, Wetmore 30088 (MIN); – birch stand 10 mi S of Hoyt Lakes, 1977, Wetmore 30491 & 30503 (MIN); – red pine plantation 7 mi S of Hoyt Lakes, 1977, Wetmore 30548 (MIN); – Voyageurs Nat. Park, on N side of Kohler Bay at W end of Namakan Lake, 1978, Wetmore 32124A (MIN); – Voyageurs Nat.

Park, at head of Mica Bay in northwestern Namakan Lake, 1978, Wetmore 33091 (MIN); – Voyageurs Nat. Park, N of Agnes Lake E of Lost Bay on Kabetogama Lake, 1978, Wetmore 33630 (MIN); – Voyageurs Nat. Park, on W side of Junction Bay across from Sheen Point in Namakan Lake, 1978, Wetmore 34785 (MIN); – Voyageurs Nat. Park, point of land 1 mi E of Anderson Bay in Rainy Lake, 1979, Wetmore 38721 (MIN); – Arlberg 2 bog, 6 mi E of Floodwood (40 mi SE of Grand Rapids), black spruce bog, 1982, Wetmore 44168 (MIN); – SOUTH DAKOTA, *Custer Co.*: Cathedral Spires Trail, 4 km E of Sylvan Lake along Needles Highway, 43°50'N, 103°32'W, alt. 1860 m, 1983, Nash 21904 (ASU); – WYOMING, *Crook Co.*: N of Moore Hill (27 mi NW of Sundance), alt. 4500 ft, 1961, Wetmore 11603 (MIN); – *Johnson Co.*: Bighorn Nat. Forest, Crazy Woman Campground, ca. 22 mi SW of Buffalo, alt. 2500 m, 1974, Weber, Kunkel & Munger L-59364 (MIN). **Mexico**, CHIHUAHUA: ridge crest area along a secondary dirt road to Casas Grandes from Bavispé, Sonora, 30°24.3'N, 108°24.3'W, alt. 2180 m, 1994, Nash 36429 (ASU) & Timdal SON60/12 (O); – trail to Cascade de Cusarare, 27°36'N, 107°34'W, alt. 2170–2200 m, 1994, Timdal SON70/12 (O); – S-facing slope of tall sierra above a secondary dirt road 40.5 km W of paved road to Creel, 28°12.3'N, 107°38.9'W, alt. 2650–2750 m, 1994, Timdal SON74/2 (O); – along route 16 ca. 20 km W of Basaseachic, 28°19.0'N, 108°15.0'W, alt. 2200 m, 1994, Timdal SON78/2 (O).

Exsiccata: Nash, Lich. Exs. ASU No. 311 (type collection).

Hypocenomyce sierrae Timdal, **sp. nov.** Fig. 1B

Species *H. oligosporae* similis, sed ascis vulgo maturis et squamis ascendentibus, sorediatis.

Type: U.S.A., California, Los Angeles Co., San Gabriel Mts, along State Hwy 2, 0.3 mi NE (road) of Newcomb Ranch, 34°20.3'N, 117°59.6'W, alt. 1650 m, on trunk of *Libocedrus decurrens*, on lower, partly charred parts, 1998.03.20, E. Timdal No. SON125/1 (O, holotype; isotypes distributed in *Tønsberg, Lich. Isid. Sored. Crust. Exs.* Fasc. 3, ined.)

Thallus squamulose; squamules up to 0.7 mm diam., normally ascending and geotropically oriented, weakly to strongly convex, with labriform soralia; upper surface grayish green or greenish brown, dull; margin crenulate, not upturned, concolorous with upper side. *Upper cortex* up to 25 µm thick, composed of thin-walled hyphae. *Apothecia* not rare, up to 0.5 mm diam., marginal, plane, black, epruinose, egyrose; margin remaining prominent, entire or flexuose; exciple composed of closely conglutinated hyphae, olivaceous in inner part, brownish black in the rim, not containing crystals, K+ brown, N– or N+ violet; hypothecium dark brown; epihymenium dark brown, not containing crystals, K+ brown, N–; paraphyses without swelling and pigment cap in apical cell; ascus with a thin, evenly amyloid tholus and covered by an amyloid cap (but often immature). *Ascospores* broadly to narrowly ellipsoid, simple, 8–11.5 × 3–4.5 µm. *Pycnidia* sessile, attached to the margin of the squamules; pycnidial wall brown, K–, N–. *Pycnospores* bacilliform, 7–10 × c. 1 µm.

Chemistry: Alectorialic acid and thamnolic acid (n=24) or thamnolic acid only (n=7); upper cortex PD+ yellow, K+ yellow, C+ red or C–, KC+ red or KC–.

Ecology and distribution: The species grows on bark and wood, especially on bark of *Libocedrus decurrens* and *Sequoiadendron giganteum*, more rarely on *Pinus* spp. and *Pseudotsuga macrocarpa*. The substrate is often charred. The habitat is conifer forests at 1380–2160 m alt. in the mountains of southern California, where it is locally one of the most common lichens on this substrate together with *H. scalaris* (Ach.) M. Choisy, *Letharia vulpina* (L.) Hue, and *Trapeliopsis flexuosa* (Fr.) Coppins & P. James; there is also one record from pinyon-juniper woodland in central Arizona (1840 m alt.).

Discussion: Morphologically, *H. sierrae* resembles *H. scalaris*, and the two species often grow in mosaics. *Hypocenomyce sierrae* differs in forming smaller, more grayish, and more crenulate squamules; in the secondary chemistry (thamnolic and usually alectorialic acid); and in forming smaller, epruinose apothecia which usually contain mature asci and spores. *Hypocenomyce scalaris* has a more brownish tinge; contains lecanoric acid (PD–, K–, C+ red, KC+ red); the apothecia are usually bluish white pruinose; and mature asci have never been observed (Timdal 1984). *Hypocenomyce sierrae* is apparently more closely related to *H. oligospora*, and differs from this species in forming ascending, geotropically oriented, sorediate squamules and in more frequently producing mature asci with spores.

Apothecia are present in many specimens, and usually contain numerous mature asci and spores. The tholus is thinner and without an axial body, but otherwise conforming to the ascus type occurring in *H. friesii* (type 2 of Timdal 1984).

Specimens examined: **U.S.A.**, ARIZONA, *Gila Co.*: Little Diamond Rim above Beaver Valley, 34°20.5'N, 111°18.5'W, alt. 1840 m, 1999, Nash 42735B (ASU); – CALIFORNIA, *Fresno Co.*: Kings Canyon Nat. Park, Grant Grove, directly N of Gamlins cabin, 1985, Blakeman 1 (MIN); – *Los Angeles Co.*: San Gabriel Wilderness, Waterman Mtn Quad., Waterman Trail Devils Canyon side of Twin Peaks Saddle, alt. 6538 ft, 1987, Neel SG53 (ASU); – San Gabriel Wilderness, Chilao Flats Quad., Devils Canyon Trail, alt. 5175 ft, 1987, Neel SG94 (ASU); – Angeles Nat. Forest, Survey 4, Mt Mooney Road, at major switchback, 34°18'N, 118°00'W, alt. 1660 m, 1989, Ryan 26184 (ASU, hb Ryan); – San Gabriel Mts, along State Hwy 2, 0.3 mi NE (road) of Newcomb Ranch, 34°20.3'N, 117°59.6'W, alt. 1650 m, 1998 Timdal SON125/1 (O, type collection); – San Gabriel Mts, along State Hwy 2, 2.3 mi SW (road) of Cloud Burst Summit, 34°21.0'N, 117°57.4'W, alt. 1940 m, 1998, Timdal SON126/1 (O); – San Gabriel Mts, along State Hwy 2, Kratka Ridge, Pacific Crest Trail parking, 34°21.7'N, 117°52.2'W, alt. 2050 m, 1998, Timdal SON127/1 (O); – San Gabriel Mts, along Charleton – Chilao road, 0.7 mi W (road) of Vicitors Center, 34°19.9'N, 118°0.9'W, alt. 1630 m, 1998, Timdal SON128/1 & 2 (O); – San Bernardino Mts, along State Hwy 173, between Lake Arrowhead and Skyforest, 34°14.6'N, 117°11.7'W, alt. 1650 m, 1998, Timdal SON130/1 (O); – *Riverside Co.*: San Jacinto Mts, Idyllwilde, Bluebird Hill Lodge, 33°44.1'N, 116°43.4'W, alt. 1600 m, 1998, Timdal SON135/1 (O); – San Jacinto Mts, along State Hwy 243 at crossing with North Fork of the San Jacinto River, 33°47.8'N, 116°44.4'W, alt. 1630 m, 1998, Timdal SON136/1 (O); – San Jacinto Mts, Black Mountain Road, 33°48.1'N, 116°45.3'W, alt. 1700 m, 1998, Timdal SON137/1 (O); – San Jacinto Mts, Black Mountain Road, 33°48.7'N, 116°44.8'W, alt. 1790 m, 1998, Timdal SON138/3 (O); – *San Bernardino Co.*: 2 mi S of Arrowhead, San Bernardino Mts, alt. 5100 ft, 1973, Nash 7086 (ASU); – *San Diego Co.*: Agua Tibia Wilderness: Magee Palomar Trail, in vicinity of Eagle Crag, 33°23'N, 117°57'W, alt. 1375 m, 1989, Ryan 25858 (hb Ryan); – *Tulare Co.*: Sequoia Nat. Park, Giant Forest, at Round Meadow, alt. 6400 ft, 1968, Rundel 3213 (COLO); – Sequoia Nat. Park, at junction of Crystal Cave road and Generals Hwy, alt. 5500 ft, 1984, Wetmore 50716 (COLO); – Seqouia Nat. Park, Muir Grove W of Dorst Campground, alt. 6400 ft, 1984, Wetmore 50982 (MIN); – Seqouia Nat. Park, E of General Sherman tree in Giant Forest, alt. 7100 ft, 1984, Wetmore 51122 (MIN); – Sequoia Nat. Park, just E of Atwell Mill Campground, alt. 6400 ft, 1984, Wetmore 51252 (COLO); – Seqouia Nat. Park, 1 mi NE of Colony Peak, alt. 5400 ft, 1984, Wetmore 51318 (MIN): – Kings Canyon Nat. Park, Grant Grove, S on Sequoia Lake Road, 3/4 mi from North Grove parking lot, 1985, Blakeman 88 (MIN); – Kings Canyon Nat. Park, Redwood Canyon, 1.5 mi from the Redwood Canyon Trailhead, toward Hart Meadow, on the Hart Tree 1985, Blakeman 207 (MIN); – Kings Canyon Nat. Park, Redwood Canyon, 3 mi S of Redwood Canyon Trailhead on Big Spring Trail, W facing slope along Redwood Creek, 1985, Blakeman 263 (MIN); – Sequoia Nat. Forest, Western Divide Hwy, 35°59.0'N, 118°35.0'W, alt. 1900 m, 1999, Rui & Timdal US249/1 (O); – Sequoia Nat. Forest, Western Divide Hwy, Cedar Slope, 36°08.9'N, 118°34.4'W, alt. 1820 m, 1999, Rui & Timdal US251/1 (O); – Sequoia Nat. Park, Giant Groove, 36°34'N, 118°46'W, alt. 2000 m, 1999, Rui & Timdal US252/1 & 2 (O); – Sequoia Nat. Park, Lost Grove, 1999 Rui & Timdal US253/1 (O); – Kings Canyon Nat. Park, Wilsonia, 36°44.6'N, 118°57.7'W, alt. 1920 m, 1999, Rui & Timdal US254/2 (O); – *Tuolumne Co.*: edge of Emigrant Wilderness, Huckleberry Trail through Kennedy Meadows, 38°17.5'N, 119°44'W, alt. 1950–2025 m, 1989, Ryan 24045 (hb Ryan); – edge of Emigrant Wilderness, above N end of Cherry Lake, 38°02'N, 119°55'W, alt. 1800–1875 m, granite rock, oak, pine, manzanita, white fir, 1989, Ryan 24615-b & 24670-c (ASU).

Exsiccata: Tønsberg, Lich. Isid. Sored. Crust. Exs., Fasc. 3 (ined., type collection).

Discussion

The rare occurrence of mature asci and ascospores in the apothecia of *H. oligospora* is of particular interest. In *Hypocenomyce*, this phenomenon is previously known from *H. australis* Timdal and *H. scalaris* (both of the *H. scalaris*-group) (Timdal 1984). The description of the ascus in the *H. scalaris*-group by Timdal (1984) was based on observation of a few asci with a poorly developed tholus in one specimen. I have later not been able to repeat this observation, and now prefer to regard the ascus in this group as being exclusively immature. In *H. scalaris*, the rich production of soredia may explain the lack of ascospore production. In the two other species, the only possible diaspores seem to be the pycnospores, unless the asci mature under certain ecological conditions. All three species grow on charred wood or bark; *H. scalaris* is also common on uncharred substrates, but produces apothecia far more frequently when growing on charred substrates (Timdal 1984). Whether the substrate is charred or not, does not seem to influence the maturation of the asci in the three species, however. If the pycnospores act as diaspores in *H. australis* and *H. oligospora*, it is hard to understand the rich production of sterile apothecia in these species. In *H. praestabilis* (Nyl.) Timdal (of the *H. xanthococca*-group), which never grows on charred substrates, there is usually a rich production of pycnospores and only a few or no apothecia; the asci do not remain immature in this species, however.

The characters separating the four species groups in *Hypocenomyce* are mainly anatomical (structures in the proper exciple, apothecial and pycnidial pigments, ascus type, shape of pycnospores) and chemical, whereas the characters uniting the groups are mainly morphological and ecological (Timdal 1984). I therefore expressed doubts about the homogeneity of the genus (Timdal 1984: 93). The *H. anthracophila*-group was placed in *Biatora* Fr. by Hafellner (1993), a view not shared by Printzen (1995). The ascus of the *H. anthracophila*-group is quite different from those of the other groups of *Hypocenomyce* (Timdal 1984), but its taxonomic position will not be discussed any further here. The two new species are in several ways intermediate between the three other groups (Table 1), and add support to keeping the three groups in one genus. They share the following features with the *H. friesii*-group: adnate squamules (in *H. friesii* and *H. oligospora*), exciple of type 2 (all species), brown epithecium with amorphous substances dissolving in K with a brown effusion (all species), ascus of type 2 (all species), and brown pycnidial wall (all species). They share the following features with the *H. scalaris*-group: ascending squamules with labriform soralia (*H. scalaris* and *H. sierrae*), immature asci (*H. australis*, *H. scalaris*, and usually *H. oligospora*), and bacilliform pycnospores (*H. oligospora*, *H. scalaris* and *H. sierrae*). They share the following features with the *H. xanthococca*-group: exciple of type 2 and presence of alectorialic acid (all species).

When placing *Hypocenomyce* in the Phyllopsoraceae, the lack of mature asci in the type species of the genus, *H. scalaris*, made Hafellner (1984) examine the ascus of *H. anthracophila* (Nyl.) P. James & Gotth. Schneid. instead. This was described as an ascus type conforming to the *Bacidia* type. In my opinion, *H. anthracophila* has a *Porpidia* type of ascus (type 1 of Timdal 1984). It now seems probable that the immature ascus found in the *H. scalaris*-group (type 3 of Timdal 1984) is reduced from

Table 1. Comparison of the *Hypocenomyce friesii*-, *H. scalaris*-, and *H. xanthococca*-groups with the two new species. Selection of characters and terminology follow Timdal (1984, Table 3), except for the exclusion of characters and states relevant only for the *H. anthracophila*-group. FR: the *H. friesii*-group, SC: the *H. scalaris*-group, XA: the *H. xanthococca*-group, *ol*: *H. oligospora*, *si*: *H. sierrae*.

Character	State	FR	SC	XA	*ol*	*si*
Growth form:	Ascending squamules	–	+	–	–	+
	Bullate squamules	+	–	–	–	–
	Adnate squamules	+	+	–	+	–
	Areolae	–	–	+	–	–
Proper exciple:	Type 2	+	–	+	+	+
	Type 3	–	+	–	–	–
Epithecium:	Brown, N–	+	–	–	+	+
	Green, N+ violet	–	+	+	–	–
Epithecium:	Without amorphous substances	–	+	–	–	–
	With amorphous subst., brown effusion in K	+	–	–	+	+
	With amorphous subst., violet effusion in K	–	–	+	–	–
Asci:	Type 2	+	–	–	(+)	+
	Type 3 (=immature)	–	+	–	+	(+)
	Type 4	–	–	+	–	–
Pycnidial wall:	Brown, N–	+	–	–	+	+
	Green, N+ violet	–	+	+	–	–
Pycnospores:	Filiform	–	+	–	–	–
	Bacilliform	±	+	±	+	+
	Ellipsoid	+	–	+	–	–
	Subglobose	–	–	+	–	–
Chemistry:	Friesii unknown	+	–	–	–	–
	Lecanoric acid	–	+	–	–	–
	Alectorialic acid	–	–	+	+	+
	Thamnolic acid	–	–	–	+	+

that occurring in the *H. friesii*-group (type 2). Whether type 2 should be considered a reduction from a *Bacidia* type ascus or from the ascus type occurring in the *H. xanthococca*-group (type 4 of Timdal 1984), is unknown. The position of *Hypocenomyce* within the Lecanorales must still be regarded as unsettled.

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STUDIES IN AMANITA (AMANITACEAE) FROM SOUTHERN ASIA. I. SOME SPECIES OF PAKISTAN'S NORTHWEST FRONTIER PROVINCE

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SUMMARY

Revision of collections made in the Northwest Frontier Province of Pakistan has resulted in determination of three previously described taxa—all here reported for the first time from Pakistan: *Amanita flavipes*, *A. orsonii*, and *A. umbrinolutea*. In addition, one taxon of *Amanita* section *Amanita* and four taxa of *Amanita* section *Vaginatae* have been found that are believed new to science. These are described as fully as possible; but, due to lack of critical data, only one new species is proposed—*A. pakistanica*. Keys are provided for the known Pakistani taxa of *Amanita* sections *Vaginatae* and *Validae*. The number of *Amanita* species reported from Pakistan is presently nine.

Key words: Agaricales, India, *Amanita pakistanica*, taxonomy

INTRODUCTION AND OVERVIEW

This paper is the first in a prospective series intended to chronicle the genus *Amanita* Pers. in southern Asia. There are several works published in the last decade that are relevant to our study. Kumar *et al.* (1990a) provide a brief review of the history of study of *Amanita* in India and present a summary of the knowledge of the genus in India at the time of publication, with special emphasis on material from Himachal Pradesh. Watling and Gregory (1980) reported three species from Jammu and Kashmir: *A. muscaria* (L.:Fr.) Pers., *A. pantherina* (DC.:Fr.) Krombh., and *A. vaginata s.l.* Yang (1997) has made an important monographic contribution with his study of *Amanita* in southwestern China—a study of great interest to all workers in regions of southern and eastern Asia with natural forests having component species from the Fagaceae and Pinaceae—as do the forests in which were made the collections treated in this paper. Tulloss and Bhandary (1992) and Tulloss *et al.* (1992a) have reported on two taxa from Nepal. It is clear from these works that mycologists in the region of interest must take into account taxa originally described from Japan and southeast Asia by Hongo, Imai, Heim, Patouillard, and others.

In addition to establishing a widely accepted sectional division of *Amanita* and transforming the study of its taxonomy, Corner and Bas (1962) addressed species of insular southeast Asia that also occur in mainland forests and, hence, are relevant to our studies. Corner and Bas cite Boedijn (1951) who also described taxa apparently related to those found in the area of interest or phenetically very similar to such taxa.

With regard to Pakistan in particular, the species list of Ahmad (1956) includes only two taxa in *Amanita*: *A. nana* Sing. and *A. vaginata* (Bull.:Fr.) Lamarck (probably to be understood in a very broad sense). In his supplements, Ahmad (1969, 1980) reported no additional species for the genus.

In this paper we report three previously described taxa as new for Pakistan: *A. flavipes*, *A. orsonii*, and *A. umbrinolutea*. For the latter two, we present the most detailed taxonomic treatments published to date. Furthermore, we give as complete descriptions as possible from existing materials for five additional taxa that we believe to be distinct and probably new to science. One is proposed as a new species—*A. pakistanica*. Unfortunately, we lack sufficient information on the remaining four to propose new names; and no single collection of any of these four seems adequate to serve as a type. Three of these taxa are designated herein by the codes of the form "PAK*n*," where *n* is an integer.

The distribution of the nine "taxa" known for Pakistan in the sections of *Amanita* is as follows:

• sect. *Amanita*	(1):	*A. PAK5*
• sect. *Vaginatae*	(5):	*A. pakistanica* *A. umbrinolutea* *A. vaginata sensu* Kumar *et al. p.p.* *A. species PAK2* *A. species PAK3*
• sect. *Lepidella*	(1):	*A. nana*
• sect. *Amidella*	(0)	-
• sect. *Phalloideae*	(0)	-
• sect. *Validae*	(2):	*A. flavipes* *A. orsonii*.

For those recognizing section *Caesareae* Sing., *A. pakistanica* and *A. species PAK2* would be assignable to it. At present, we are reserving judgment on division of section *Vaginatae*.

METHODS

Collections forming the basis of our studies were made by Iqbal and Khalid as part of research on ectomycorrhizal macromycetes of *Pinus* in Pakistan. Since 1994, the first three authors have been in contact with each other to discuss occasional collections of *Amanita* collected in conifer forest between 2400 and 2600 m elev. in the Northwest Frontier Province, Pakistan. One of the frustrating aspects of the interaction at first was the difficulty in getting a dried specimen from the field to the U.S.A. without losing key tissues due to the drying process itself or due to subsequent attack by molds. Collecting in liquid was prohibitive when complete fruiting bodies were considered, and shipment of such specimens would have been liable to damage that could have destroyed the specimens. Iqbal and Khalid took up the approach of sending small samples of the most easily damaged, important tissues (above all, the lamellae) in small containers with FAA. At the suggestion of R. E. Halling (NY), Tulloss adds glycerine upon receipt of the containers to forestall loss due to evaporation. This has worked very well for us and has allowed us to prepare this preliminary report on *Amanita* in the region of interest.

Other methods and terminology follow those of Tulloss *et al.* (1992b) and Tulloss (1993, 1994). Color codes of the form "6D6" are from (Kornerup & Wanscher, 1978). Color codes of the form "10YR 4/3" are from (Munsell Color, 1975). Color names in italics with initial capital letters (*e.g.*, *Empire Yellow*) are from Ridgway (1912), and conversions from Ridgway's names to Munsell color codes is based on the work of Hamly (1949). The abbreviationn "s.d." stands for "standard deviation." With two exceptions (HKAS—Herbarium of Cryptogams, Kunming Institute of Botany, Academia Sinica, Kunming, Yunnan, People's Republic of China; RET—Tulloss' personal herbarium), abbreviations of names of herbaria follow Holmgren *et al.* (1990).

TAXONOMIC PART

Subgenus *AMANITA*

Section *AMANITA*

One collection assignable to this section was examined. No notes on macroscopic characters were available. Because of a thin, but pronounced, membranous limb surrounding the stipe base, the exsiccata suggest *Amanita pantherina* var. *velatipes sensu* Kumar *et al.* (1990a) *non* Atk. More and better annotated material is required before a description of good quality can be produced. We have assigned this taxon the code *Amanita sp. PAK5*. The following data on basidiospores was obtained: [40/2/1] (9.0-) 9.6 - 12.1 (-13.5) × (6.6-) 7.0 - 8.5 (-9.1) µm, (**L** = 10.5 - 10.9 µm; **L'** = 10.7 µm; **W** = 7.7 µm; **W'** = 7.7 µm; Q = (1.26-) 1.28 - 1.53 (-1.57); **Q** = 1.37 - 1.41; **Q'** = 1.39), hyaline, colorless, thin-walled, smooth, inamyloid, broadly ellipsoid to ellipsoid, adaxially flattened, occasionally swollen at one end; apiculus sublateral, cylindric, proportionately broad and low; contents dominantly monoguttulate with additional small granules; color in deposit unrecorded.

Amanita muscaria should be sought in association with *Betula* as was reported from Jammu and Kashmir by Watling and Gregory (1980).

Section *VAGINATAE* (Fr.) Quél.

Key

1. Stipe exannulate.

  2. Pileus zonate or distinctly bicolored at maturity; saccate universal veil attached to sides of stipe base—not only at very base.

    3. Pileus (dark?) grayish brown to dark gray over disc, otherwise becoming off-white to light gray to golden brown with expansion, progressively paler toward margin; pileipellis with substantial gelatinized suprapellis (60 - 100 µm thick); universal veil limb becoming decorated with orange or ochraceous, verruculose spots; spores 10.0 - 11.7 (-12.1) × (8.5-) 9.2 - 10.4 (-11.2) µm, with **Q** = 1.08 - 1.14; in Pakistan from 2400 - 2600 m elev., with *Pinus wallichiana* or with *Abies pindrow* and *Cedrus deodara* in mixed forest. .... *Amanita species PAK3.*

    3. Pileus with disc umber to grayish umber-brown to beige or pale grayish brown (even within single collection), with middle zone beige to grayish beige to somewhat yellowish gray-beige, with outer zone (over inner ends of striations and

between striations) rather dark gray-brown but sometimes paler; pileipellis gelatinizing only at surface; universal veil becoming grayish in upper part of limb in age as well as becoming decorated with orange or ochraceous spots; spores (10.0-) 10.5 - 13.2 (-17.2) × (9.0-) 9.5 - 12.3 (-14.3) µm, with **Q** = 1.09 - 1.11; in Pakistan occurring with *Pinus* at 2500± m elev.; European material examined associated with *Picea* .... *Amanita umbrinolutea.*

2. Pileus not zonate, dark brown in exsiccata; universal veil attached only at very base of stipe; spores (9.5-) 10.0 - 13.5 (-16.5) × (8.5-) 9.2 - 12.2 (-15.0) µm, with **Q** = 1.07 - 1.09; in Pakistan at 2500 m elev., with *Pinus roxburghii* and reportedly common in Himachal Pradesh, India, from 1500 - 2600 m elev., with *P. roxburghii* and, at higher altitudes, *Picea smithiana* and *Abies pindrow*. .... *Amanita vaginata sensu* Kumar *et al. p.p.* [excluding *Amanita pseudovaginata* Hongo].

1. Stipe annulate.

4. Pileus cream at margin, with color gradually becoming more tan toward brown disc; lamellae white to pale pinkish white; universal veil attached in part to sides of stipe base; spores (10.0-) 10.1 - 12.2 (-12.8) × (6.5-) 7.0 - 8.8 (-9.2) µm, with **Q** = 1.29 - 1.48; in Pakistan at 2400± m elev., with *Abies pindrow*. .... *Amanita pakistanica.*

4. Pileus orange-brown over disc and throughout pileus in unexpanded specimens, orange to orangish tan to yellowish tan to grayish yellow to pale brownish ochraceous toward margin in more mature material, with ridges in striate region concolorous with disc and grooves yellow-orange, entirely yellow to pale ochraceous in age; lamellae yellow; universal veil attached only at very base of stipe; spores (7.9-) 8.8 - 11.0 (-14.0) × (6.0-) 6.4 - 7.7 (-9.3) µm, with **Q** = 1.35 - 1.47; in Pakistan at 2400 - 2600 m elev., with *Abies pindrow* or with that tree and *Taxus wallichiana* in mixed forest; other material examined from markets in Nepal. *Amanita species PAK2.*

1. ***Amanita pakistanica*** Tulloss, Iqbal & Khalid *sp. nov.*

Figs. 1-4

Pileus usque ad 80 *mm latus, umbonatus, albus vel cremeus, disco subbubalino vel subcinnamomeo vel spadiceo, margine striato* (0.15R - 0.2R), *interdum fragmentis albis veli universalis. Lamellae liberae, confertae, albae vel pallidoroseae; lamellulae truncatae. Stipes usque ad* 150 × 10 *mm, albus, sursum decrescens; annulus albus, membranaceus, superus vel submedianus, tenuis, margine incrassato; velum universale saccatum, album, (sub)membranaceum, breviter affixum ad latera stipitis ad infimum. Basidia tetrasterigmata; fibulae praesentes. Subhymenium structura propria stirpis Hemibapha. Sporae* (10.0-) 10.1 - 12.2 (-12.8) × (6.5-) 7.0 - 8.8 (-9.2) *µm, late ellipsoideae vel ellipsoideae;* **Q** = 1.29 - 1.48. *Holotypus*: Pakistan, Northwest Frontier Prov., Hazara Distr., Nathiagali, 24.viii.1999 A. N. Khalid 24899 (LAH).

Etymology: In honor of the country of Pakistan.

PILEUS: up to 80 mm wide, white to cream-colored to pale tan with orange-tan to light brown to brown disc, campanulate to convex when young, plane then concave at

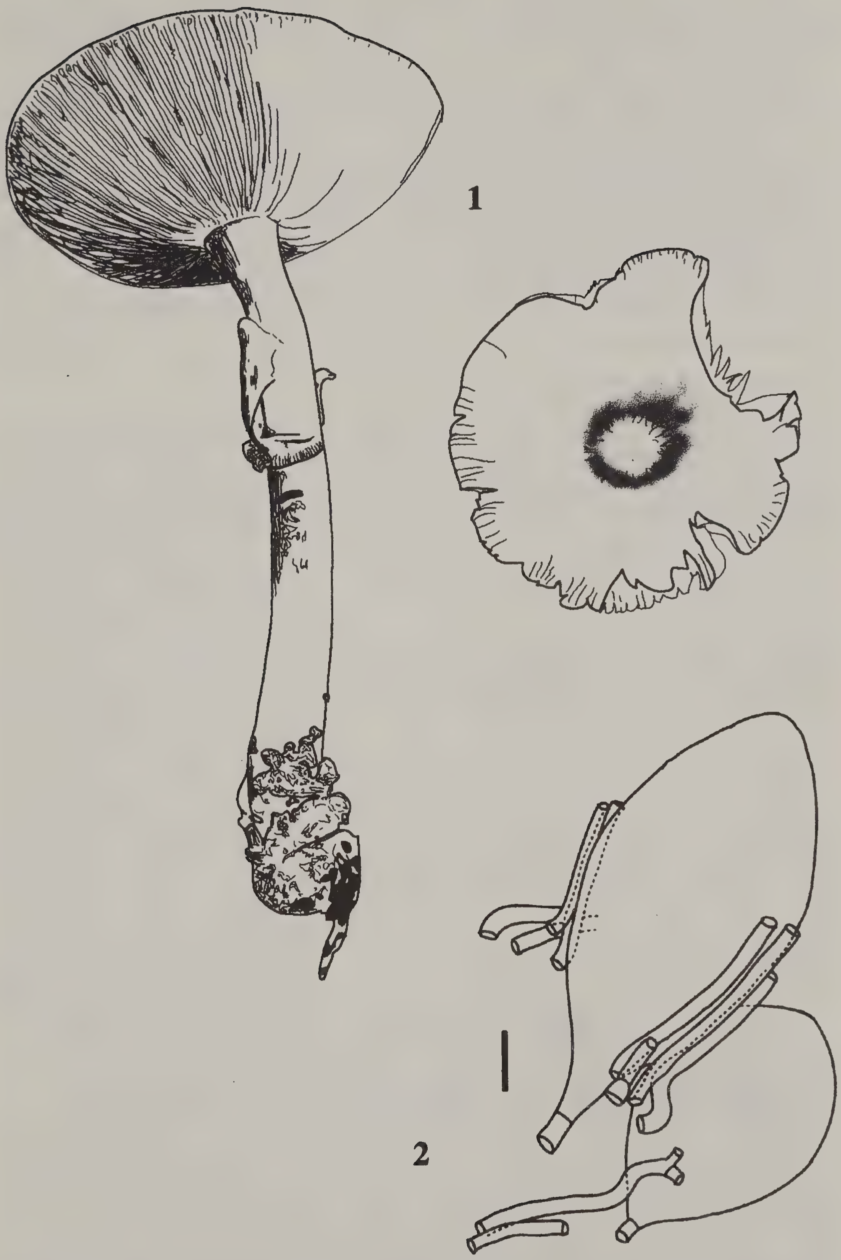


Fig. 1-2. *Amanita pakistanica* (A. N. Khalid 1071994). 1. Habit (×0.60). 2. Elements of universal veil from stipe base.

maturity, umbonate; *context* white, rather fleshy; *margin* striate (0.15R - 0.2R), nonappendiculate; *universal veil* absent or as patches or small flakes, white, membranous to submembranous, detersile.

LAMELLAE: free, crowded, white to pale pinkish; *lamellulae* truncate, of diverse lengths, plentiful, unevenly distributed.

STIPE: up to 150 × 10 mm, white, narrowing upward, with pallid ridges encircling or partially encircling the stipe at various angles in lower half; *context* white; *partial veil* superior to supramedian, white, membranous, pendant, thin and rather easily torn, with edge slightly thickened; *universal veil* as saccate volva, up to 32 × 30 μm, subovoid, membranous to submembranous, white to off-white, sheathing, attached in part to sides of stipe base, with *limbus internus* small and placed at point of attachment to stipe.

Odor and *taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 60 - 75 μm thick, orange-yellow to yellow-orange to orange-brown, with very limited partial gelatinization and decoloration present only at surface (one or two hyphal layers), not distinctly divided into sub- and suprapellis; filamentous, undifferentiated hyphae 2.6 - 8.3 μm wide, branching, subradially arranged, closely packed horizontally and vertically; vascular hyphae 3.2 - 14.1 μm wide, infrequently branching, common, sinuous; clamps rather common. PILEUS CONTEXT: filamentous, undifferentiated hyphae 2..6 - 11.5 μm wide, branching, plentiful, singly and in fascicles interwoven in open lattice structure; acrophysalides plentiful, thin-walled, clavate to broadly clavate to subpyriform, *e.g.*, 104 × 52 μm; vascular hyphae 4.5 - 23 μm wide, infrequently branching, scattered; clamps present, frequency unknown due to condition of available material. LAMELLA TRAMA: based on material preserved in FAA; bilateral; w_{cs} = 40 - 55 μm (good rehydration); central stratum comprising filamentous, undifferentiated hyphae with partially inflated intercalary cells (ellipsoid to elongate to clavate to narrowly clavate) up to 22 μm wide; divergent, inflated cells predominantly (if not all) intercalary, subclavate, up to 20 m wide; filamentous, undifferentiated hyphae 2.0 - 6.0 μm wide, branching; refractive hyphae 1.8 - 2.8 μm wide, sinuous, rare; clamps present. SUBHYMENIUM: based on material preserved in FAA; $w_{st\text{-}near} = 50^-$; $w_{st\text{-}far} = 70^-$ (good rehydration, but measured closer to pileus than to middle of lamella);comprising two layers of inflated cells (globose to subglobose to ellipsoid to narrowly ellipsoid, infrequently clavate, up to 22 × 20 μm), cell subtending basidium dominantly having major diameter perpendicular to central stratum, with basidia arising from cells of all shapes. BASIDIA: 36 - 49 × 7.7 - 11.2 μm, 4-, and occasionally 2-sterigmate, with sterigmata up to 5.0 × 2.6 μm; clamps rather common. UNIVERSAL VEIL: *On pileus*: similar in overall structure to material on stipe base, compressed vertically, outer layer sometimes missing, inflated cells dominating throughout remainder. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae in fascicles and singly, in moderately open lattice structure, with many hyphae sublongitudinally oriented, gelatinized to partially gelatinized. *On stipe base, interior*: filamentous, undifferentiated hyphae 2.6 - 12.5 (-22) μm wide, branching, singly and in narrow fascicles, interwoven in open lattice structure, dominating near exterior surface, infrequently with yellowish subrefractive walls; inflated cells terminal singly, common, dominating away from exterior surface (especially near inner surface), sometimes clustered locally, thin-walled, clavate to broadly clavate to ellipsoid to broadly ellipsoid, up to 191 × 90 μm, rather commonly ≥ 100 μm long, smaller and proportionately narrower near exterior surface; vascular hyphae scattered, very infrequent, 10.2 - 22 μm wide, sinuous, occasionally branching; clamps scattered, unevenly distributed. *On stipe base, inner surface*: thin fragmented layer; filamentous, undifferentiated hyphae gelatinized to partially gelatinized, fasciculate, frequently with sublongitudinal orientation. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.5 - 8.8 μm wide, branching, dominating at surface; acrophysalides thin-walled, dominating away from surface, up to 508 × 36 μm, commonly with length ≥ 250 μm; vascular hyphae presence uncertain (if present then rare, weakly pigmented, $9.0^{\pm}$ μm wide). PARTIAL VEIL: description based on material preserved in FAA; partially gelatinized in material available; filamentous, undifferentiated hyphae 1.0 - 5.0 μm wide, dominating, with dominant radial orientation, with plentiful branching, often in broad fascicles; inflated cells uncommon, clavate, thin-walled, collapsing, up to 47 × $15^{\pm}$ μm, radially oriented; vascular hyphae 3.0 - 6.0 μm wide, sinuous, infrequent.

BASIDIOSPORES: [80/4/2] (10.0-) 10.1 - 12.2 (-12.8) × (6.5-) 7.0 - 8.8 (-9.2) μm, (**L** = 10.5 - 11.6 μm; **L'** = 11.0 μm; **W** = 7.8 - 8.1 μm; **W'** = 8.0 μm; Q = (1.17-) 1.23 - 1.64 (-1.97); **Q** = 1.29 - 1.48; **Q'** = 1.39), hyaline, colorless, thin-walled, smooth, inamyloid, broadly ellipsoid to ellipsoid, infrequently elongate; apiculus sublateral, cylindric; contents dominantly monoguttulate, occasionally multiguttulate; color in deposit unrecorded.

Habitat and distribution: Solitary. Pakistan: At $2400^{\pm}$ m elev. Associated with *Abies pindrow* Spach.

Collection examined: **PAKISTAN**: N.W. FRONTIER PROV.—Hazara Distr. - Nathiagali, 10.vii.1994 A. N. Khalid 1071994 (LAH; RET), 24.viii.1999 A. N. Khalid 24899 (holotype, LAH; isotype, NY).

DISCUSSION

Assignable to stirps *Hemibapha* and having a pallid pileus with brownish coloration over the disc and a universal veil attached in small part to the sides of the stipe, this species is macroscopically quite similar to *A. murrilliana* Sing. (1950) (≡*Venenarius gemmatus* var. *volvatus* Murr.), which is known from infrequent occurrence in forests including either evergreen or deciduous *Quercus spp.* or forests dominated by *Tsuga and Betula* in eastern North America. The American species can be distinguished from the present one at least by the following:

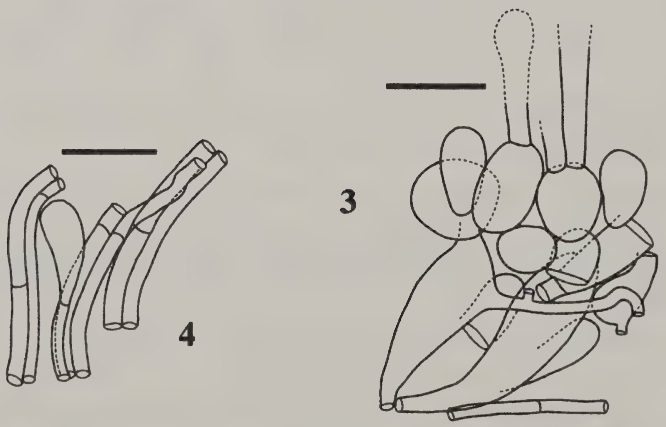
- spores that are, on average, slightly longer and slightly narrower (Tulloss, unpub. data): **L'** = 11.4 μm; **W'** = 7.7 μm; and **Q'** = 1.49
- a more robust volval limb containing fewer, notably smaller, inflated cells [The largest such cell noted was less than 100 μm long (Tulloss, unpub. data).]
- markedly longer marginal striations on the pileus (up to 0.55R).

The present taxon also somewhat suggests *A. longistriata* Imai (1938) of Japan. Yang (1997: 55-56) and Yang and Doi (1999) discuss what is presently known of *A. longistriata*. Based on Yang's work, it appears that some Japanese works presenting *A. longistriata* illustrations are actually illustrating *A. incarnatifolia* Z. L. Yang (≡*A. rhodophylla* Imazeki & Toki *non* Beeli). Yang and Doi provide information on recent collections of *A. longistriata*. They report the lamellae to be subdistant to distant and spore data as follows: [175/8/5] (8.0-) 9.0 - 12.0 (-13.5) × (7.5-) 8.0 - 10.0 (-11.0) µm with Q = (1.02-) 1.06 - 1.33 (-1.53), **Q'** = 1.19 ± 0.08 [s.d.]. This conforms well with Yang's data from very damaged fragments of what may be the type of the species: [100/1/1] (9.5-) 10.0 - 13.0 (-14.0) × (7.5-) 8.0 - 11.0 (-12.0) µm, with Q = (1.03-) 1.11 - 1.35 (-1.56), **Q'** = 1.22 ± 0.08 [s.d.]. Yang reported that pileus marginal striations in *A. longistriata* encompass 0.3R - 0.5R (sometimes, 0.2R - 0.25R *per* Yang and Doi). Hence, *A. longistriata* differs from *A. pakistanica* at least in

- markedly longer marginal striations on the pileus
- subdistant lamellae
- broader spores with markedly lower **Q'**
- pileus color much darker—brownish gray to nearly fuligineous over the disc [according to the protologue, *Drab* (10YR 5.5/3.0) or *Buffy Brown* (10YR 5.5/4.0) or *Clove Brown* (10YR 2.8/1.5)] with dark brown ridges between marginal striations
- volva proportionately much longer (up to 50 × 35 mm) and attached only at very base of stipe (see reproduction of Imai's water color published by Gilbert (1941: Tab. 7).

Amanita incarnatifolia, is another taxon that might be placed in stirps *Hemibapha* and has a rather broad attachment of the stipe base to the universal veil (Yang, 1997: fig. 37). It can be distinguished from *A. pakistanica* by the following observations of Yang (1997: 52, 54):

- The pileus of *A. incarnatifolia* is grayish, gray, gray-brown, or brown and, often, is dark brown over the disc. Further it lacks an umbo (indeed is sometimes depressed over the disc).



Figs. 3-4. *Amanita packistanica* (NY isotype). 3. Elements of hymenium and lamella trama from material preserved in FAA. 4. Elements of partial veil from material preserved in FAA.

- Its stipe is shorter in proportion to the pileus diameter and reported not to exceed 90 mm in length.
- More than half of the thickness of the pileipellis comprises a distinct, gelatinized suprapellis.
- The universal veil is more robust and has narrower filamentous, undifferentiated hyphae.

In addition to the collections that formed the basis of the description of the present taxon, a third collection was examined that might be assignable to *A. pakistanica* [Khanspur, 10.viii.1996 A. N. Khalid 9896 (LAH; RET)]. Unfortunately, the collection was not described or photographed in fresh condition. There is no annulus visible on the exsiccata of the collection. It is possible that the collection is assignable to stirps *Hemibapha* based on the few microscopic characters that can be discerned. The spores, however, do not provide unqualified support for assigning this collection to *A. pakistanica*: [40/1/1] (9.5-) 9.6 - 12.0 (-13.3) × 7.5 - 9.9 (-12.0) µm, (**L** = 10.8 µm; **W** = 8.6 µm; Q = (1.15-) 1.18 - 1.37 (-1.45); **Q** = 1.27).

The present species has been called "*Amanita species PAK4*" in correspondence and in keys that have been publicly circulated.

2. *AMANITA UMBRINOLUTEA* (Secr. *ex* Gill.) Bataille. 1910. *Bull. Trimestriel Soc. Mycol. France* 26: 139.

≡*Amanita inaurata* f. *umbrinolutea* Secr. *ex* Gill. 1874. *Champ. (Hyménomyc.) Croiss. France*: 42. [Misapplication.]

≡*Amanita umbrinolutea* ("*umbrino-lutea*") Secr. *nom. inval.* 1833. *Mycogr. Suisse* 1: 34. [Name of specified rank (species) in suppressed work. ICBN §32.8, App. V.]

≡*Amanita vaginata* var. *umbrinolutea* ("*umbrino-lutea*") (Secr. *ex* Gill.) E. J. Gilb. 1918. *Gen. Amanita Pers.*: 146.

≡*Amanita vaginata* subsp. *badia* var. *umbrinolutea* (Secr. *ex* Gill.) Konr. & M. 1924. *Icones Sel. Fung., Texte*: 34.

≡*Amanitopsis umbrinolutea* (Secr. *ex* Gill.) E. J. Gilb. 1928. *Bull. Trimestriel Soc. Mycol. France* 44: 164.

≡*Amanita vaginata* f. *umbrinolutea* (Secr. *ex* Gill.) Veselý. 1933. *Ann. Mycol.* 31(4): 279.

≡*Amanitopsis vaginata* var. *umbrinolutea* (Secr. *ex* Gill.) E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 75.

≡*Amanitopsis umbrinolutea* (Secr. *ex* Gill.) Courtecuisse "*comb. ined.*" 1986. *Clé Determin. Macroscop. Champ. Supér. Régions Nord France*: 15/20b-24b. [The combination would have been superfluous if made.]

≡*Amanitopsis vaginata* var. *umbrinolutea* (Secr. *ex* Gill.) Wasser. 1988. *Ukrayins'k. Bot. Zhurn.* 45(6): 77. [Superfluous combination.]

Figs. 5-6

PILEUS: 46 - 72 (-86) mm wide, zonate with three zones (with darkest zones over disc and marginal striations), over disc umber to grayish umber-brown (10YR 4/3-4) to beige or pale grayish brown (*e.g.*, 10YR 7/3-4) even within single collection, in middle zone beige to grayish beige to somewhat yellowish gray-beige (10YR 6/3-4 or 10YR

7/3-4 or between 10YR 7/4 and 10YR 6-7/6), outer zone (over inner ends of striations and between striations) rather dark gray-brown (10YR 5/3-4 or 10YR 4/3) but sometimes paler, at first conico-paraboloid, soon broadly conical, then plano-conical, then plano-convex with umbo, finally subplanar with low obtuse subconical umbo; *context* white, membranous approximately in area of striations; *margin* sulcate-striate (0.25R - 0.35R), nonappendiculate; *universal veil* absent.

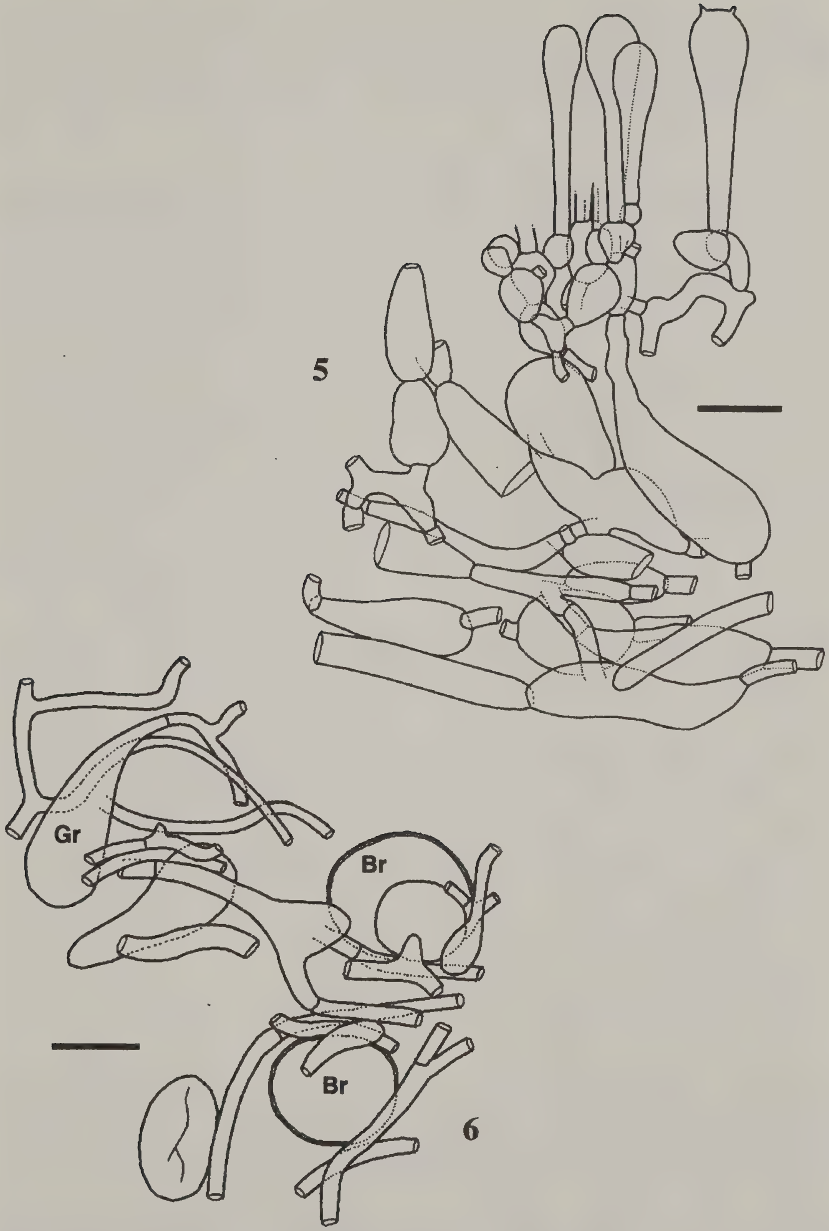
LAMELLAE: free and leaving narrow groove around stipe apex, crowded (approx. 10 - 12 in 10 mm arc at midradius of pileus), off-white to sordid pale cream, up to 6 mm broad, with thin rather straight gray-brown to yellowish gray-brown edge; *lamellulae* truncate, scattered, unevenly distributed (sometimes entirely missing from sector making up 25% or more of pileus), at most one between any pair of lamellae, of diverse lengths.

STIPE: 115 - 155 (-185) × 6 - 11 mm, pale cream to pale beige or isabella color or pale grayish brownish, with faint appressed zigzag girdles of fibrils (at first very pale pinkish brownish, sometimes brownish yellow, later increasingly gray-brown, finally becoming quite distinct on pale background), narrowing upward, slightly or markedly flaring at apex; *context* hollow; *exannulate*; *universal veil* as saccate volva, copious, white to sordid white, with few or many orange-brown spots on exterior, with approximately upper third to half becoming grayish with age, 30 - 40 mm high, of which 25 - 35 mm free from stipe, at first fleshy membranous and up to 2 mm thick, circumcissile or 2 - 3 lobed, with *limbus internus* small, subfloccose, visible only in younger basidiocarps, positioned at about midheight of free limb (volva bitangent), often evanescent.

Odorless. *Taste* indistinct.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 105 - 160 (-195) µm thick, colorless at surface in layer ranging from minimal to 80 µm thick, subtended by brownish orange region (progressively paler toward pileus context) 60 - 120$^+$ µm thick, gelatinized only just at surface, lacking pronounced division into supra- and subpellis; filamentous, undifferentiated hyphae 3.2 - 7.6 µm wide, branching, sometimes constricted at septa, with common slightly inflated intercalary segments up to 12.7 µm wide, occasionally with yellowish subrefractive walls, occasionally strongly pigmented (orange-brown) in most strongly pigmented region, dominantly subradially arranged; refractive or vascular hyphae 6.1 - 12.1 µm wide, sinuous, scattered throughout, locally common. PILEUS CONTEXT: filamentous, undifferentiated hyphae 3.7 - 7.6 µm wide, branching, forming open lattice, in fascicles and singly, sometimes with yellowish subrefractive walls, often constricted at septa; acrophysalides narrowly clavate to clavate, up to 94 × 35 µm, with walls thin or up to 1.0 µm thick; inflated cells in subradially oriented chains just above interlamellar basidia giving impression of pseudoparenchymatous tissue, ellipsoid to subglobose (*e.g.*, 32 × 27 µm) or broadly allantoid to broadly fusiform to elongate-ellipsoid to subcylindric (*e.g.*, 35 × 19 µm); vascular hyphae 4.8 - 9.0 µm wide, scattered throughout to locally common. LAMELLA TRAMA: bilateral; w_{cs} = (40-) 50 - 80 µm (excellent rehydration, higher numbers from material preserved in FAA and glycerine); central stratum comprising filamentous, undifferentiated hyphae and plentiful inflated intercalary cells (ellipsoid to clavate to subfusiform, up to 83 × 26 µm); subhymenial base with angle of divergence predominantly 45° - 60°, with plentiful ellipsoid to elongate ellipsoid to subfusiform to obclavate to narrowly obclavate inflated cells (up to 75 × 32 µm); filamentous,



Figs. 5-6. *Amanita umbrinolutea* (Brandrud & Stordal 24317). 5. Elements of hymenium and lamella trama. 6. Elements of interior of universal veil from limb at stipe base (**Br** indicates a brown cell. **Gr** indicates a gray cell).

undifferentiated hyphae 3.6 - 11.0 µm wide, branching, common in central stratum and subhymenial base; terminal, divergent inflated cells not observed; vascular hyphae 5.5 - 10.2 µm wide, sinuous, scattered. SUBHYMENIUM: w_{st}-near = (75-) 85 - 105 (-120) µm (excellent rehydration, higher numbers from material preserved in FAA and glycerine); w_{st}-far = (90-) 100 - 125 (-155) µm (excellent rehydration, higher values obtained from material preserved in FAA and glycerine); comprising inflated and partially inflated cells in branching structure (with uncommon uninflated hyphal segments here and there), with two to three layers of inflated cells between bases of longest basidia and subhymenial base; with most basidia arising from inflated cells. BASIDIA: 33 - 77 (-85) × 11.6 - 20 µm, often thin-walled, also with walls up to 1.0 µm thick especially in broadest part, dominantly 4-, occasionally up to one-third 2-sterigmate, with sterigmata up to 7.6 × 3.1 µm; dextrinoid granules not observed; clamps not observed. UNIVERSAL VEIL: *On pileus*: as scattered gelatinized microscopic fragments or absent. *On stipe base, exterior surface*: with scattered fascicles of subgelatinized to gelatinized filamentous, undifferentiated hyphae outermost and dominantly sublongitudinally oriented, with rather dense lattice of interwoven straight filamentous, undifferentiated hyphae as second layer (singly or in narrow fascicles, scattered hyphae exposed at surface partially gelatinized) with scattered inflated cells (collapsed, colorless to brown, ellipsoid to ovoid to subpyriform to subglobose to globose, up to 67 × 61 µm). *On stipe base, interior*: filamentous, undifferentiated hyphae 2.3 - 15.2 (-24) µm wide, branching, commonly curved or loosely coiled, dominating, rather densely interwoven, occasionally with yellowish subrefractive walls, singly or in fascicles; inflated cells terminal, singly or in chains of two, not tightly bound by surrounding hyphae, most frequently colorless, also slightly sordid to yellow-brown to brownish, globose to subglobose to subpyriform to broadly ovoid to ovoid (up to 105 × 80 µm, but rarely larger than 90 × 75 µm) and broadly clavate to clavate to subfusiform to subcylindric (up to 75 × 38 µm), with walls thin or up to 0.6 µm thick, unevenly distributed, plentiful locally; vascular hyphae 3.2 - 9.8 µm wide, scattered, sinuous. *On stipe base, inner surface*: with much area comprising exposed interior tissue (near top of limb especially), with scattered fascicles of sublongitudinally oriented gelatinized hyphae, especially lower on limb with such fascicles densely packed in broad patches or strips suggesting pileipellis. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 3.8 - 8.7 µm wide, branching, common, singly or in fascicles, plentiful near surfaces; acrophysalides up to 275 × 46 µm, dominating away from surfaces, with walls thin or up to 0.8 µm thick; refractive hyphae 8.9 - 19.0 µm wide, sinuous, rarely branching.

BASIDIOSPORES: [140/7/4] (10.0-) 10.5 - 13.2 (-17.2) × (9.0-) 9.5 - 12.3 (-14.3) µm, (**L** = 11.0 - 12.2 (-13.2) µm; **L'** = 11.8 µm; **W** = 10.1 - 11.1 (-12.1) µm; **W'** = 10.8 µm; Q = (1.04-) 1.05 - 1.14 (-1.34); **Q** = 1.09 - 1.11; **Q'** = 1.10), hyaline, colorless, thin-walled, smooth, inamyloid, subglobose to (occasionally) broadly ellipsoid; apiculus sublateral, truncate-conic to cylindric; contents monoguttulate; occasionally with some spores containing central flocculent body appearing to be supported by radiating filaments attached to spore walls; color in deposit unrecorded for collections examined.

Habitat and distribution: Subgregarious. Estonia: In *Picea* forest with plentiful *Corylus* on rather acid but probably mineral-rich loamy soil. Pakistan: At 2500 m elev. With *Pinus roxburghii* Sarg. and *P. wallichiana* A. B. Jackson or with *P. excelsa* Lam.

Collections examined: **PAKISTAN**: NW FRONTIER PROV.—Hazara Distr. - Ayoubia-Khanspur, 10.viii.1995 A. N. Khalid 10895 (LAH (*n.v.*); RET), 10.viii.1997 S.

H. Iqbal & A. N. Khalid *s.n.* (LAH; RET).

Extralimital collections examined: **ESTONIA**: *ca.* 16 km S of Villandi, 26.viii. 1989 C. Bas 9203 (DTJ (*n.v.*); L (*n.v.*); RET). **NORWAY**: Gjövik Co. - tract around Honne in Biri [NN 8858 (1816 I)], 24.viii.1985 T. E. Brandrud & J. Stordal 24317 (O).

DISCUSSION

Because of the incomplete state of knowledge of the taxonomy of *A. umbrinolutea* (see below), material from Pakistan was compared to a collection from Estonia and a second, clearly conspecific collection from Norway. It is particularly important that the Estonian collection was described in considerable detail in its fresh state by the collector, Dr. C. Bas (Rijksherbarium, Leiden) and therefore is known to strongly conform to Secretan's description of the present species.

The European and Pakistani collections were compared:

- Habit and pigmentation of the basidiocarps are extremely similar in the European and Pakistani collections.
- A few inflated cells in the volva of the Pakistani material were slightly larger than any seen in the European material. Otherwise, the structure of the universal veil is identical in the two sets of material.
- A very slight difference in the numerical parameters of the lamellae was noted, but this was attributed to comparison of rehydrated tissue in the European collections with material preserved in liquid in the Pakistani collections.
- Structure of the lamella trama in the two sets of material is nearly identical.
- Allowing for the presence of giant spores (seven of 20 measured) in one of the Pakistani collections (Khalid 10895), *A. umbrinolutea* spores from Europe and Pakistan were very similar: [100/5/2] (10.0-) 10.5 - 12.8 (-17.2) × (9.0-) 9.5 - 11.5 (-13.7) µm, (**L** = 11.0 - 12.2 µm; **L'** = 11.5 µm; **W** = 10.1 - 11.0 µm; **W'** 10.5 µm; Q = (1.04-) 1.05 - 1.15 (-1.26); **Q** = 1.09 - 1.11; **Q'** = 1.10) in the European material and [40/2/2] (10.5-) 11.4 - 13.9 (-16.4) × (9.5-) 10.5 - 12.6 (-14.3) µm, (**L**= 12.1 - 13.2 µm; **L'** = 12.7; **W** = 11.1 - 12.1 µm; **W'** = 11.6 µm; Q = 1.04 - 1.13 (-1.34); **Q** = 1.09; **Q'** = 1.09) in the Pakistani material. [For the best preserved Pakistani collection (date 10.viii.1997) the match to the European data is very good: [20/1/1] (10.5-) 11.0 - 12.8 (-15.1) × (9.5-) 9.9 - 11.6 (-13.0) µm, (**L** = 12.1 µm; **W** = 11.1 µm; Q = 1.04 - 1.11 (-1.34); **Q** = 1.09).]

We conclude that the Pakistani and European collections are conspecific.

The volva of *A. umbrinolutea* is rather unusual since it remains coherent throughout the life of the basidiocarp, but also includes inflated cells that may eventually discolor to brown as are found in taxa of *Amanita* section *Vaginatae* with less coherent universal veil such as *A. castaneogrisea* Contu, *A. ceciliae* (B. & Br.) Bas, *A. olivaceogrisea* Kalamees, *A. sinicoflava* Tulloss, and *A. submembranacea* (Bon) Gröger. Recently, two taxa that are somewhat similar macroscopically have been described in detail from southwestern China—*A. atrofusca* Z. L. Yang and *A. lignitincta* Z. L. Yang *nom. prov.*; however, neither has a subhymenium largely composed of inflated cells as in the present species. This can be seen in the superb and detailed illustrations of Yang (1997: figs. 56 & 67). In Tulloss' current classification of the species of section *Vaginatae* (unpub. data), the species that is most similar phenetically to *A. umbrinolutea* is *A. pekeoides* Ridley (1991), described from New Zealand. *Amanita pekeoides* can be distinguished (Tulloss, unpub. data) from the present taxon by its having

- a pileus with reddish or vinaceous tints
- a pileipellis 70 - 100 µm thick
- inflated cells in its universal veil that are apparently all unpigmented and are smaller [up to 53 × 27 µm (most under 30 × 20 µm)], less common, and thin-walled
- lamellae lacking a colored edge
- smaller inflated cells in the lamella trama (none seen larger than 35 × 20 µm).

The great variation in spore dimensions given by European mycologists for the present species is somewhat puzzling and has suggested to several authors that there may be more than one species involved. The same impression can be obtained from the variety of colors (*e.g.*, with some strong reddish tints) depicted for the pileus of the present species in various illustrations. It is also possible that some investigators have reported finding giant spores, and some have not. The situation of *A. umbrinolutea* taxonomy prior to the current work is discussed in brief by Fraiture (1993: 70-73). Fraiture says that most current authors describe the spores as globose and 10 - 12 (-13) µm. Allowing for the usual overemphasis of roundness common to most descriptions of subglobose spores in *Amanita* (Tulloss, 1994), this size is in approximate agreement with spore data from the collections we examined.

The unusual and unexplained phenomenon of spores on occasional basidiocarps having central flocculent bodies supported by fine filaments attached to the interior of the spore wall was noted both in Bas 9203 and in an English collection [Epsom Common, Prince's Covert, 1.xi.1984 C. Whaley *s.n.* (K)] discussed by Tulloss and Halling (1997: 287).

For comparison with *A. species PAK3*, see the discussion following description of that entity, below.

3. *AMANITA VAGINATA sensu* Kumar *et al. p.p.* 1990a. *Amanitaceae India*: 86, 110, fig. 16 (A-E). [Excluding *Amanita pseudovaginata* Hongo that appears to have been included among the collections cited by Kumar *et al.* (Tulloss, unpub. data).]

Fig. 7

Note: The description of Kumar *et al.* (1990a) is reproduced in the discussion section for this taxon. We believe that description treats basidiocarps of more than one species and, consequently, have included no information from it in the following.

PILEUS: probably grayish when fresh, very dark brown in exsiccatum, umbonate; *text* unrecorded; *margin* striate (0.3R$^{\pm}$), nonappendiculate; *universal veil* usually absent, infrequently as large membranous patch over disc, pallid.

LAMELLAE: unrecorded.

STIPE: with thin grayish surface layer in several exsiccata; *context* stuffed with white cottony fibrils; *exannulate*; *universal veil* as saccate volva, white or whitish, membranous, tubular, connected only at very base of stipe, with *limbus internus* not recorded.

Odor and *taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 100 - 160 μm thick, with gelatinized suprapellis lacking or up to 25 μm thick, with ungelatinized subpellis 100 - 160 μm thick divided into upper unpigmented region (minimal to 45 μm thick) and lower region gradually more intensely pigmented until orange-brown near interface to pileus context; filamentous, undifferentiated hyphae 1.9 - 6.4 μm wide, branching, subradially oriented; vascular hyphae 2.5 - 12.0 μm wide, sinuous, scattered to (occasionally) locally common, occasionally in tangles, sometimes penetrating surface. PILEUS CONTEXT: sometimes with faint brown tint in mass; filamentous, undifferentiated hyphae 2.9 - 10.2 μm wide, branching, in fascicles and singly, interwoven in open lattice structure; acrophysalides clavate, plentiful, thin-walled, up to 152 × 48 μm; vascular hyphae 2.5 - 10.2 μm wide, occasionally branching, sinuous, scattered throughout to moderately common. LAMELLA TRAMA: bilateral; w_{cs} = 40 - 55 μm (from material preserved in FAA and glycerine); central stratum dominated by filamentous, undifferentiated hyphae, with only occasional partially inflated intercalary segments; subhymenial base dominated by frequently branching filamentous, undifferentiated hyphae, but with plentiful inflated intercalary cells (broadly clavate, elongate-ellipsoid, ellipsoid, ovoid, up to 65 × 31 μm), with angle of divergence predominantly between 45° and approx. 80°; filamentous, undifferentiated hyphae 2.5 - 7.0 μm wide, branching; terminal, divergent inflated cells not observed; vascular hyphae not observed. SUBHYMENIUM: w_{st}-near = 60 - 75 μm (from material preserved in FAA and glycerine); w_{st}-far = 70 - 95 μm (from material preserved in FAA and glycerine); with numerous inflated cells, but branching structure obvious throughout, with inflated branched cells and short partially inflated hyphal segments also common, with 1 - 2 (-3) layers of cells between longest basidia and subhymenial base; with basidia arising from inflated cells or infrequently from partially inflated cells. BASIDIA: 44 - 70 × 13.3 - 21 μm, dominantly 4-, occasionally 2-, infrequently 3- or 1-sterigmate, with sterigmata up to 8.0 × 2.8 μm; clamps not observed. UNIVERSAL VEIL: *On pileus, exterior surface*: as on stipe base. *On pileus, interior*: more compressed (vertically) than on stipe base; filamentous, undifferentiated hyphae 3.2 - 7.6 μm wide, branching, dominating, singly and in narrow fascicles, interwoven in rather dense lattice structure, sometimes with yellowish subrefractive walls; inflated cells clavate to broadly clavate, thin-walled, occasionally yellowish, up to 110 × 50^{-} μm, scattered, possibly in chains of two (infrequently); vascular hyphae not observed. *On pileus, bottom surface*: pileipellis-like layer of gelatinized to partially gelatinized to ungelatinized filamentous, undifferentiated hyphae, apparently carrying away from pileipellis most gelatinized hyphae from region of gelatinization, slightly to distinctly brownish. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae 2.7 - 11.7 μm wide, branching, sometimes with yellowish subrefractive walls, in plentiful smoothly curving criss-crossing fascicles, partially gelatinized, colorless, with small gaps through which interior visible; vascular hyphae not observed. *On stipe base, interior*: filamentous, undifferentiated hyphae 2.5 - 11.4 μm wide, branching, interwoven in dense lattice structure, dominating; inflated cells subfusiform to clavate to broadly clavate (up to 95 × 36 μm, usually less than 70 × 25 μm) or subglobose to subpyriform (up to 60 × 52 μm), fragile, collapsed, scattered, infrequently in small clusters or in chain of two, thin-walled; vascular hyphae not observed. *On stipe base, inner surface*: suggesting pileipellis; filamentous, undifferentiated hyphae in distinct orange-brown layer, partially gelatinized, dominantly sublongitudinally oriented, closely packed; vascular hyphae not observed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.0 - 9.5 μm wide, branching, common, plentiful near surfaces; acrophysalides up to 335 × 38 μm, with walls thin or up to 0.6 μm thick, dominating away from surfaces; vascular hyphae 6.5 - 11.5 μm wide, scattered, occasionally locally common or in dense tangles.

BASIDIOSPORES: [70/4/2] (9.5-) 10.0 - 13.5 (-16.5) × (8.5-) 9.2 - 12.2 (-15.0) μm, (**L** = 11.7 - 12.1 μm; **L'** = 11.9 μm; **W** = 11.0 - 11.2 μm; **W'** = 11.1 μm; Q = (1.01-) 1.05 - 1.12; **Q** = 1.07 - 1.09; **Q'** = 1.08), hyaline, colorless, thin-walled although sometimes slightly thickened in region of apiculus, smooth, inamyloid, globose to subglobose, adaxially flattened; apiculus sublateral, stocky, cylindric to truncate-conic; contents mono- to multiguttulate often with numerous finer granules, sometimes granular; white in deposit.

Habitat and distribution: Solitary to scattered to gregarious. Pakistan: At 2500 m elev. Associated with *Pinus roxburghii*. Himachal Pradesh, India: From 1700 m elev. On soil rich in humus under *Pinus roxburghii* in mixed forest containing *Rhododendron arboreum* Smith, *Quercus incana* Roxb., *Cornus capitata* Sesse & Moc., and *P. wallichiana*.

Collection examined: **PAKISTAN**: NW FRONTIER PROV.—Hazara Distr. - Ayoubia-Khanspur, 10.viii.1997 S. H. Iqbal & A. N. Khalid *s.n.* (LAH; RET).

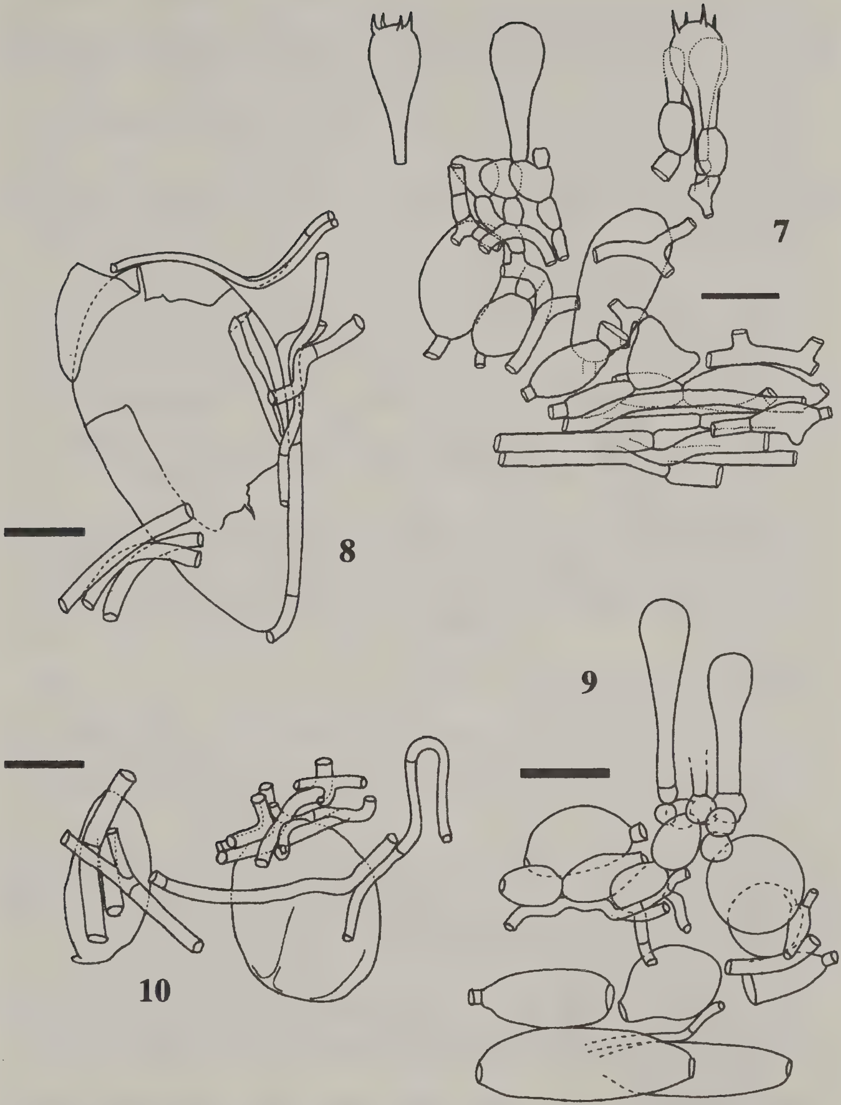
Extralimital collection examined: **INDIA**: HIMACHAL PRADESH—Shimla Distr. - Chadwick Fall, 28.vii.1984 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 1143 (*n.v.*); BPI 71989).

DISCUSSION

Amanita vaginata sensu Kumar *et al.* seems closely related to *Amanita vaginata sensu* Yang (1997: 87). Yang's excellent figure of the lamella trama and hymenium of that entity (Yang, 1997: fig. 70) is strikingly similar to our illustration of the same tissues in the present taxon (Fig. 7). However, at present, we note the following among the differences between the two organisms:

- The spores of Yang's species are smaller and rounder—(9.0-) 9.5 - 11.0 (-14.0) × (8.5-) 9.0 - 10.5 (-13.5) μm, with **Q** = 1.04±0.03 [s.d.].
- The inflated cells of the universal veil in Yang's species are commonly subglobose to ellipsoid.
- The tissues of the saccate volva and the stipe are merged in the bottom 10 mm of the stipe.
- The pileipellis has a 40 - 80 μm thick suprapellis of gelatinized hyphae.
- The marginal striations of the pileus are in the range of 0.15R to 0.25R—proportionately shorter than in the present taxon.

HPUB 1552 was cited in Kumar *et al.* (1990a) under "*Amanita vaginata*." One specimen from the collection may belong here based on its spores. However, the collec-



Figs. 7-10. Fig. 7. *Amanita vaginata sensu* Kumar *et al. p.p.* (Iqbal & Khalid *s.n.*) elements of hymenium and lamella trama from material preserved in FAA. Fig. 8. *Amanita species PAK2* (Khalid 95810) elements of universal veil from stipe base. Figs. 9-10. *Amanita species PAK3*. 9. Elements of hymenium, subhymenium, subhymenial base, and central stratum, with elements of central stratum displaced from subhymenial base due to sectioning (Khalid 23795). 10. Elements of universal veil from stipe base (Khalid 881994).

tion is in poor condition and is mixed; consequently, data on the material is omitted from the above description. The collection contains at least one basidiocarp that is probably assignable to *A. pseudovaginata*. Yang (1997: 91) notes that, prior to his monograph, mycologists of China included three taxa in a very broad concept of *A. vaginata*: *A. ovalispora* Boedijn *sensu* Z. L. Yang, *A. pseudovaginata* Hongo, and "*A. cf. vaginata*." It is interesting to find that the concept of *A. vaginata* that Kumar *et al.* applied in Himachal Pradesh also includes more than one component species. It is for this reason that the macroscopic description from Kumar *et al.* was not provided as the description for the present species. However, that description is repeated here for the convenience of the reader:

> PILEUS: 60 - 90 mm, grayish brown to brownish gray (7E2-3), fleshy to brittle, ovoid to campanulate when young, broadly convex to convex to nearly plane with maturity, umbonate, smooth, viscid when wet; *context* white, unchanging when cut or bruised, thin; *margin* regular, decurved to straight, striate (up to 0.5R); *universal veil* absent or as white, membranous patches.
>
> LAMELLAE: free, crowded, white to "pale white" [*sic*?], up to 5 mm broad, fleshy to brittle, thin, edges entire; *lamellulae* in at least 2 to 3 lengths.
>
> STIPE: 90 - 140 × 8 - 20 mm, white to grayish white, tapering upward, smooth fibrillose, with fibrils thin white appressed and turning gray with age, viscid when wet; *context* white unchanging when cut or bruised, usually fistular; *exannulate*; *universal veil* as a saccate to cup-like volva, thick, membranous, white, free of stipe, sheathing one-third to one-quarter of the stipe, persistent.
>
> *Odor* and *taste* not distinctive.
>
> MACROCHEMICAL TESTS: Aniline water - negative on pileipellis, reddish brown on pileus context. Concentrated HNO_3 - negative on pileipellis, yellowish on pileus context. 2% aqueous phenol - negative on pileipellis, pinkish red on pileus context.

Ahmad (1956) mentions "*A. vaginata*" as occurring in Murree (Rawalpindi Distr.) in The Punjab and Nathiagali (Hazara Distr.) and Bahrain and Swat (Swat Distr.) in the N.W. Frontier Prov. However, it cannot be assumed that these references are to a single taxon, much less that they refer to the present one.

Sohi *et al.* (1964) reported "*A. vaginata*" from forest areas of Solan, Himachal Pradesh at 5,000 ft. elev. and illustrated spores of this "species" as both subglobose and ellipsoid or broadly ellipsoid—again suggesting that there are multiple taxa assigned to this species in Himalayan India.

Further, Singh and Mehrotra (1974) report multiple pileus colors in their ellipsoid-spored "*A. vaginata*" from Allahabad, Uttar Pradesh:

> Pileus 5-10 cm, oval when young then convex and flattened when old, thin, glabrous, a little viscid, furrowed at the margin, yellowish-white or grey, regular in form but fragile and easily broken; trama white, thin; lamellae free, emarginate, white; stipe 7-11 cm long without a ring but sheathed at the base by a white, saccate, membranous persisting volva, slender, fragile, glabrous, hollow, without a bulbous base; spores smooth, hyaline, subglobose [sic], 7.5-

12 × 6-7.5 μ.

Further collecting and careful study will be required to understand the "complex" of taxa refered to *A. vaginata* in the region of study.

4. AMANITA SPECIES PAK2

Figs. 8, 11

PILEUS: 73 - 180 mm wide, orange-brown (6C-D8) over disc and throughout pileus in unexpanded specimens, orange to orangish tan to yellowish tan (5A-B7 or 4B7) to grayish yellow to pale brownish ochraceous toward margin, with ridges in striate region concolorous with disc and grooves yellow-orange (4A7), entirely yellow to pale brownish ochraceous in age, irregularly ovoid to campanulate at first, then convex or planoconvex, finally plane or subconcave, umbonate, smooth or slightly wrinkled around umbo, moist; *context* orange (5A7) below pileipellis, then grading through yellow-orange (4A7-8) to white toward lamellae, with white portion near gill attachment becoming grayish yellow to yellowish gray (3B5 to 3C4-6) on cutting or bruising; *margin* striate (0.35 - $0.5^{\pm}$R), somewhat incurved at first, remaining decurved even when pileus fully expanded, nonappendiculate; *universal veil* absent; *pileipellis* peeling.

LAMELLAE: free, close, pale yellow (3A3-4) in side view, up to 6 mm broad, with some reverse forking close to stipe, with edge yellow-orange (4A6-7) and flocculose or occasionally dentate-serrate and darkening on aging or bruising to light brown or orange-brown (5-6D7) and finally to dark brown (6F8); *lamellulae* truncate to rounded truncate, common, unevenly distributed, of diverse lengths.

STIPE: 100 - 300 × 10 - 23 mm, sometimes pale yellowish at first (palest below partial veil), orange-yellow to yellow-orange (4A6-7) to pale ochraceous brown in mature material, narrowing upward slightly, slightly flaring at apex, minutely longitudinally striatulate, floccose-fibrillose, with fibrous squamules orangish tan (5C7-8), becoming ochraceous brown or brownish orange (6C7-8), finally dark brown (6-7E-F8); *context* pale yellow (3A3), unchanging when cut or bruised, hollow, with central cylinder lined with moist cottony fibrils; *partial veil* superior, membranous, copious, skirt-like, at first concolorous with stipe, then with color changing as in fibrils on stipe surface, eventually much more strongly pigmented than stipe and pileus in age, $22^{\pm}$ mm long, finely striate above, eventually tearing and collapsing on stipe; *universal veil* as saccate volva, up to $67^{\pm}$ × $27^{\pm}$ mm, ellipsoid, very thick, leathery, white on exterior surface and internally, color on inner surface not recorded (but slightly darker than exterior surface in some exsiccata), connected only to very bottom of stipe.

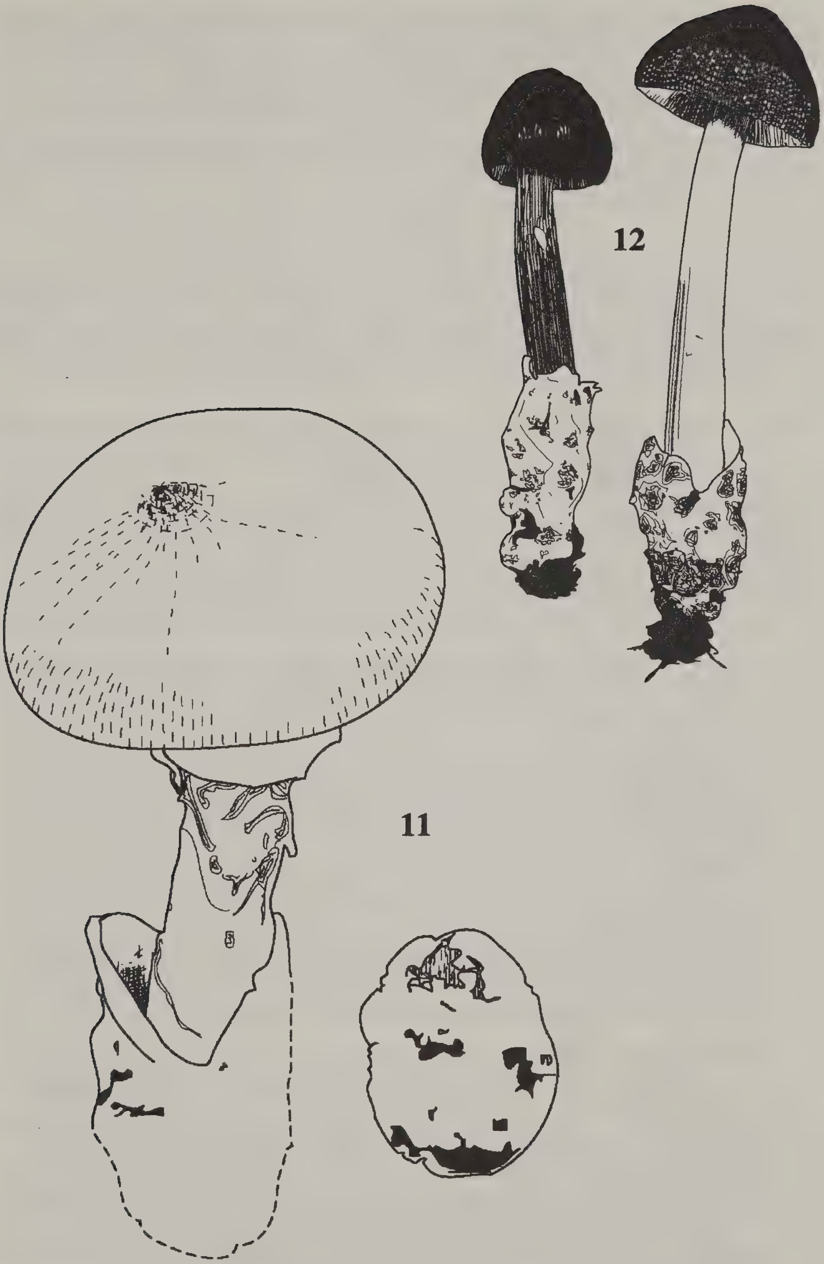
Odor and *taste* not recorded. EDIBLE, sold in markets in Nepal.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 65 - 155 (-205) μm thick; suprapellis 10 - 70 μm thick, colorless to yellowish, comprising partially gelatinized to gelatinized hyphae; subpellis 40 - 105 (-160) μm thick, orange-brown to yellow-orange to orangish yellow to brownish yellow, comprising ungelatinized to partially gelatinized and occasionally collapsed hyphae; filamentous, undifferentiated hyphae 0.7 - 4.8 μm wide, branching, densely packed vertically, dominantly subradially oriented; vascular hyphae 3.4 - 25 μm wide, relatively common (at least locally), sinuous, infrequently branching, often loosely coiling or twisting (especially those of smaller diameter); clamps present. PILEUS CONTEXT: filamentous, undifferentiated hyphae 1.6 - 10.9 μm wide, branching, plentiful throughout, dominant near pileipellis and lamellae, in open lattice structure, occasionally in fascicles; acrophysalides common (at least at distance from pileipellis and lamellae), narrowly clavate to clavate to narrowly ellipsoid to broadly fusiform to fusiform, up to 79 × 42 μm or larger (good rehydration not achieved), thin-walled; vascular hyphae 2.5 - 13.0 μm wide, not common, not observed in some sections, infrequently branching, sinuous; clamps present. LAMELLA TRAMA: bilateral; w_{cs} not measured due to condition of material; subhymenial base comprising frequently branching, filamentous, undifferentiated hyphae and closely packed intercalary cells (thin-walled, up to 44 × 10.5 μm and then extending approximately from central stratum to subhymenium, sometimes in short chains); with central stratum containing similar intercalary cells; filamentous, undifferentiated hyphae 2.0 - 5.0 μm wide, branching; terminal, divergent inflated cells not observed; vascular hyphae not observed; clamps present. SUBHYMENIUM: w_{st}-near and w_{st}-far not measured due to condition of material; pseudoparenchymatous (cellular), with one to three cells between bases of longest basidia/-oles and subhymenial base, with basidia arising from inflated cells. BASIDIA: 33 - 52 × 8.1 - 10.0 μm, 4-sterigmate, with sterigmata up to 3.0 × 1.5 μm; clamps rather common locally, often prominent. UNIVERSAL VEIL: *On pileus*: absent. *On stipe base, exterior surface*: $25^{\pm}$ μm thick, comprising extensively gelatinized pale yellowish very loosely interwoven hyphae. *On stipe base, interior*: filamentous, undifferentiated hyphae 2.5 - 16.5 μm wide, branching, in fascicles and singly, dominantly with sublongitudinal orientation, densest near surfaces; inflated cells narrowly clavate to clavate to broadly fusiform to ellipsoid to ovoid, up to 159 × 58 μm, unevenly distributed, locally plentiful (clustered); vascular hyphae 5.1 - 9.5 μm wide, scattered, subsinuous; clamps present. *On stipe base, inner surface*: < 10 hyphal diameters thick, partially gelatinized, comprising sublongitudinally oriented filamentous, undifferentiated hyphae up to $3.5^{\pm}$ μm wide. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 1.9 - 12.7 μm wide, branching, plentiful, sometimes in fascicles; acrophysalides plentiful, dominant in interior, often rounded at base, thin-walled, up to 241 × 42 μm, not infrequently having clavate subterminal cell; vascular hyphae not observed; clamps not infrequent. PARTIAL VEIL: filamentous, undifferentiated hyphae 1.6 - 4.0 μm wide, branching, predominantly radially arranged, dominating, commonly in fascicles, partially gelatinized in material reviewed (23.vii.1994 Bhandary *s.n.*); inflated cells clavate, with major axis radially oriented, apparently infrequent, but frequency difficult to judge due to state of tissues, up to 41 × 15.0 μm or larger; vascular hyphae 5.0 - 7.9 μm wide, sinuous, occasional to infrequent, often subradially arranged; clamps not observable.

BASIDIOSPORES: [100/4/4] (7.9-) 8.8 - 11.0 (-14.0) × (6.0-) 6.4 - 7.7 (-9.3) μm, (**L** = 9.5 - 10.5 μm; **L'** = 9.8 μm; **W** = 6.9 - 7.2 μm; **W'** = 7.0 μm; Q = (1.25-) 1.29 - 1.54 (-2.0); **Q** = 1.35 - 1.47; **Q'** = 1.39), hyaline, colorless, thin-walled, smooth, inamyloid, ellipsoid, occasionally broadly ellipsoid, infrequently elongate, rarely cylindric, adaxially flattened, often expanded at one end (Nepali material—see discussion, below); apiculus sublateral, cylindric to truncate-conic, short; contents monoguttulate with or without additional small granules; white in deposit.

Habitat and distribution: Solitary to subgregarious. Pakistan: At 2400 - 2580 m elev. Associated with *Abies pindrow* or with that tree and *Taxus wallichiana* in mixed forest.



Figs. 11-12. Fig. 11. *Amanita species PAK2* (A. N. Khalid 481994) habit (×0.33). Fig. 12. *Amanita species PAK3* (A. N. Khalid 23796) habit (×0.62).

Collections examined: **PAKISTAN**: N.W. FRONTIER PROV.—Hazara Distr. - Ayoubia, Kuzagali, Nathiagali, 10.viii.1994 A. N. Khalid 481994b (LAH; RET); Ayoubia-Khanspur, 10.viii.1995 A. N. Khalid 95810 (LAH; RET), 12.viii.1996 A. N. Khalid 11896 (RET); Dungagali, 6.vii.1994 A. N. Khalid 481994a (LAH; RET).

Extralimital collection examined: **NEPAL**: no locality (purchased in market), 23.vii.1994 H. R. Bhandary *s.n.* (RET).

DISCUSSION

While this is a very distinctive taxon, to date, no collection includes a well-preserved piece of partial veil; and no collection has lamella trama that is rehydratable. Presence or frequency of clamps could not be determined for some tissues because of the condition of the exsiccata. Unfortunately, several dry collecting seasons have prevented collection of more material of *A. species PAK2*.

In a provisional key to taxa that are phenetically similar to *A. hemibapha* (B. & Br.) Sacc., Tulloss (1998) segregates a group of taxa with 95% of spores having length less than or equal to 12.0 µm and **Q** greater than or equal to 1.33 in which *A. species PAK2* is included. The taxa described in this group to date include *A. hemibapha* subsp. *javanica* Corner & Bas (1962) described from Java; *A. hemibapha* subsp. *similis sensu auct. japon.* (*e.g.*, Hongo, 1975; Imazeki and Hongo, 1987; and Imazeki *et al.*, 1988), known from Japan; and *A. masasiensis* Härkönen & Saarimäki *in* Härkönen *et al.* (1994), described from Tanzania. These taxa differ from the present species as follows:

- *Amanita hemibapha* subsp. *javanica* is based on *A. hemibapha sensu* Boedijn (1951: 320-322). Boedijn's description is of an entity with smaller basidiocarp (stipe ≤ 130 × 12.5 mm), smaller basidia (≤ 36 µm long), dirty white pileus context, an *Orange-Buff* (8.5YR 7.2/9.0) partial veil, and an *Apricot Yellow* (2.5Y 7.8/9.5) to *Empire Yellow* (4Y 8.2/10.0) to *Pinard Yellow* (5.0Y 8.4/8.0) stipe decorated with *Orange-Buff* (8.5YR 7.2/9.0) squamules before becoming glabrous.
- *Amanita hemibapha* subsp. *similis sensu auct. japon.* has a dark brown to umbrinous pileus (even fuligineous at first) [5D6 to 5E5 *per* Hongo (1975)] that does not become yellow or ochraceous with age, and its partial veil and stipe decorations [according to illustrations of Imazeki *et al.* (1988) and Imazeki and Hongo (1987)] are pale orangish buff at first and become browner with age although apparently remaining rather pallid.
- *Amanita masasiensis* has a yellow-orange pileus with a red-orange disc that is hemispheric in early development, lacks an umbo, and may become centrally depressed at maturity. According to its protologue, its basidiocarps are considerably smaller than those of the present taxon, with a pileus ≤ 70 mm wide and stipe ≤ 70 × 11 mm. The stipe is pale yellow. Trees associated with the African species are all indigenous to miombo woodland at less than 1,000 m elev. (*e.g.*, *Uapaca* and *Brachystegia*) and do not include any members of the *Pinaceae* or *Fagaceae*. No changes in color with aging of the basidiocarp are reported for *A. masasiensis*.

The thickness of the suprapellis of *A. species PAK2* in well-preserved exsiccata probably falls near the upper end of the range given above. The thinnest examples of suprapellis were found on specimens with considerable mold on the pileus—if not other surfaces. This mold may have destroyed part of the suprapellis.

The material from Nepal was purchased in a market and, hence, was apt to experience some drying or other stress between the time it was collected and the time it was purchased, annotated, and dried. This may have caused the spores to be slightly narrower than might otherwise be expected. The conditions surrounding the collection and drying of Khalid 481994a & b are not recorded. The 1995 collection of Khalid took 8 hours to dry thoroughly at a distance of 10 cm from a room heater.

There were some "giant spores" present in Khalid 481994b. No spores could be found on Khalid 481994a.

Unfortunately, no known photograph of the present taxon has the pileus margin clearly in focus; hence, the marginal striations are only presented schematically in Fig. 11.

5. AMANITA SPECIES PAK3

Figs. 9-10, 12

PILEUS: 40 - 100 mm wide, dark gray to gray to dark grayish brown to brown over disc, otherwise yellow-brown to brownish yellow (becoming paler with expansion) and progressively paler (approaching off-white) toward margin, campanulate to broadly campanulate at first, then convex, eventually plane with umbo; *context* off-white, thin, brittle; *margin* subtuberculate-striate ($0.35^{\pm}$R), nonappendiculate; *universal veil* absent.

LAMELLAE: nearly free to free, crowded, off-white to pale yellowish cream; *lamellulae* shape not recorded, scattered, very infrequent in some sectors, of diverse lengths.

STIPE: 100^{-} - 140 × 5 - 15 mm, at first white or gray with satiny sheen due to longitudinal fibrils of surface, then when such fibrils present, becoming paler and less shiny from white ground color appearing between fibrils due to stipe expansion, sometimes surface becoming finely fibrillose-squamulose in fully expanded specimens and then this surface decoration sometimes staining brown, narrowing upward; *context* white, unchanging when cut or bruised; *exannulate*; *universal veil* as saccate volva, off-white to cream with ochraceous spots and stains, sheathing, adhering to sides of stipe below, abruptly narrowed to rounded point at base, appearing to have areolate surface with areolae as irregular patches capped with roughly central verruculose ochraceous wart-like structures and separated by very white material of interior, with *limbus internus* not described.

Odor and *taste* not recorded.

MACROCHEMICAL TESTS: none recorded.

PILEIPELLIS: 95 - 115 μm thick (mature specimen) or 150 - 190 μm thick (least mature specimen), with colorless suprapellis of extensively gelatinized hyphae 60 - 85 μm thick (most mature specimen) or 65 - 100 μm thick (least mature specimen), with yellowish subpellis of ungelatinized hyphae 25 - 55 μm thick (most mature specimen) or 70 - 110 μm thick (least mature specimen); filamentous, undifferentiated hyphae 1.9 - 7.8 μm wide, branching, criss-crossed when viewed from above; vascular hyphae 3.8 - 16.0

µm wide, sinuous, infrequent, unevenly distributed, both at surface and within suprapellis (and there remaining ungelatinized). PILEUS CONTEXT: filamentous, undifferentiated hyphae 2.8 - 7.9 µm wide, branching, singly and in fascicles interwoven in open lattice structure, plentiful; acrophysalides not describable due to tissue damage; vascular hyphae not observed. LAMELLA TRAMA: bilateral; $w_{cs} = 20^{\pm}$ µm (least mature specimen); hyphae of central stratum with common intercalary fusiform segments (up to at least 62 × 21 µm), subhymenial base apparently containing filamentous, undifferentiated hyphae and inflated cells (thin-walled, intercalary, up to 29 × 17.8 µm or larger), angle of divergence not determinable; filamentous, undifferentiated hyphae 1.4 - 7.5 µm wide, branching; terminal divergent, inflated cells not observed; vascular hyphae 3.3 - 12.6 µm wide, occasionally branching, common, sinuous, coiling or "knotted." SUBHYMENIUM: w_{st}-near = 35 - 40 (least mature specimen); w_{st}-far = 50 - 55 µm (least mature specimen); pseudoparenchymatous (cellular) at least locally, comprising 2 - 3 layers of cells, with basidia arising from inflated cells. BASIDIA: 46 - 64 × (7.7-) 11.3 - 15.2 µm, 4-, and occasionally 2-sterigmate, with sterigmata up to 6.2 × 2.7 µm; clamps not observed. UNIVERSAL VEIL: *On pileus*: absent. *On stipe base, exterior surface*: filamentous, undifferentiated hyphae 2.5 - 9.0 µm wide, branching, singly and in fascicles interwoven loosely, with interior easily visible, partially gelatinized to gelatinized, colorless, often becoming brownish orange with gelatinization, sometimes with yellowish subrefractive walls, with many fascicles having sublongitudinal orientation in part; inflated cells scattered, unevenly distributed, terminal singly, colorless to pale sordid to faintly brownish orange (from gelatinization), globose to ellipsoid (up to 52 × 45 µm) or clavate (up to 65 × 20 µm), thin-walled; vascular hyphae not observed (refractive hyphae of mold noted in material examined). *On stipe base, interior*: filamentous, undifferentiated hyphae 1.9 - 11.5 µm wide, commonly branching, sinuous to loosely coiling, singly and in fascicles interwoven in lattice structure, dominating; inflated cells common to locally plentiful, unevenly distributed, terminal singly, globose to ellipsoid (up to 78 × 60 µm) or clavate (*e.g.*, 35 × 16.0 µm), with walls thin or slightly thickened; vascular hyphae 2.9 - 12.8 µm wide, branching, common near inner surface, unevenly distributed. *On stipe base, inner surface*: like interior but compressed partially gelatinized and agglutinated, 5 - 15 µm thick, brownish orange. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.3 -7.8 µm wide, branching, singly and in fascicles, dominating near exterior surface, otherwise plentiful; acrophysalides plentiful in interior, absent at surface, thin-walled, up to 155^{+} × 35 µm; vascular hyphae 4.2 - 17.8 µm wide, occasionally branching, sinuous, common, unevenly distributed.

BASIDIOSPORES: [29/2/2] 10.0 - 11.7 (-12.1) × (8.5-) 9.2 - 10.4 (-11.2) µm, (**L** = 10.6 - 11.2 µm; **L'** = 10.8 µm; **W** = 9.8 - 9.9 µm; **W'** = 9.8 µm; Q = 1.05 - 1.15 (-1.36); **Q** = 1.08 - 1.14; **Q'** = 1.10), hyaline, colorless, thin-walled, smooth, inamyloid, occasionally at least somewhat adaxially flattened, subglobose, rarely broadly ellipsoid or ellipsoid; apiculus sublateral, small, cylindric; contents monoguttulate; color in deposit unrecorded.

Habitat and distribution: Solitary or in pairs. Pakistan: At 2400 - 2600 m elev. With *Pinus wallichiana* or with *Abies pindrow* and *Cedrus deodara* (Roxb.) Loud. in mixed forest.

Collections examined: **PAKISTAN**: N.W. FRONTIER PROV.—Kaghan Distr. - Shahran, Kaghan Valley, 22.vii.1995 A. N. Khalid 23795 (LAH; RET). Hazara Distr. - Kuzagali, 8.viii.1994 A. N. Khalid 881994 (LAH; RET).

DISCUSSION

Of all the taxa studied by Tulloss to date, this species falls closest to *A. umbrinolutea* and *A. pekeoides* Ridley (1991) from New Zealand (Tulloss, unpub. data). The present taxon differs from both these species in

- lacking a dark zone over the marginal striation of the pileus
- having a pileipellis divided into substantial supra- and subpellis
- having hyphae of the pileipellis criss-crossed rather than subradially arranged
- having a commonly areolate external surface of the volval sac
- apparently having lower values for w_{cs}, w_{st}-near, and w_{st}-far.

In addition, *A. species PAK3* differs from *A. umbrinolutea* in

- apparently having somewhat smaller spores (So few were found and measured that judgment on this point cannot be final.)
- lacking basidia with thickened cell walls
- having common, pyriform to nearly globose cells in the subhymenial base
- in the universal veil interior, lacking elements with walls ≥ 0.5 μm thick and having smaller inflated cells
- as far as is known, lacking any grayish tint to the volval limb in all stages of development
- as far as is known, lacking any grayish tint to the lamellae.

Also, *A. species PAK3* differs from *A. pekioides* at least in

- having substantially smaller spores (spores of *A. pekeoides*: [200/10/7] (8.4-) 10.2 - 13.5 (-17.5) × (7.5-) 9.5 - 12.6 (-17.0) μm, (**L** = (10.9-) 11.5 - 12.8 μm; **L'** = 12.0 μm; **W** = (10.0-) 10.2 - 11.8 μm; **W'** = 11.1 μm; Q = (1.03-) 1.04 - 1.15 (-1.58); **Q** = 1.06 - 1.10 (-1.13); **Q'** = 1.09)
- having a volval sac not attached solely at the very bottom of the stipe base
- lacking reddish or vinaceous tints on the pileus.

Subgenus *LEPIDELLA* (E. J. Gilb.) Veselý *emend.* Corner & Bas

Section *LEPIDELLA*

No previously unreported taxa of this section were collected during the present study. *Amanita nana* Sing. of subsection *Vittadiniae* is known from the Punjab (Ahmad, 1956; Bas, 1969; Tulloss, unpub. data).

Section *AMIDELLA* (E. J. Gilb.) Konr. & M.

No material assignable to this section was collected during the present study; and, so far as we know, no taxon of this section has ever been reported from Pakistan.

Section *PHALLOIDEAE* (Fr.) Quél.

No material assignable to this section was collected during the present study; and, so far as we know, no taxon of this section has ever been reported from Pakistan.

Section *VALIDAE* (Fr.) Quél.

Key

1. Context becoming pinkish when cut or bruised; pileus becoming shades of red or brown with exposure or age, originally neither deep yellow nor brownish yellow nor deep orange; spores (6.5-) 7.0 - 9.2 (-10.5) × (5.0-) 5.5 - 7.0 (-8.0) µm, with **Q** = 1.23 - 1.34 (-1.39); in Pakistan, with *Cedrus deodara*; in Himachal Pradesh and Uttar Pradesh, India, with *Abies*, *Cedrus*, *Picea*, *Pinus*, *Quercus*, and *Rhododendron*. .... *Amanita orsonii*.

1. Context not becoming pinkish when cut or bruised; pileus deep yellow to brownish yellow to deep orange; spores (6.0-) 6.8 - 8.5 (-11.0) × (5.0-) 5.2 - 6.5 (-8.8) µm, with **Q** = 1.27 - 1.34 (-1.38); in Pakistan, with *Abies pindrow*; in Himachal Pradesh and Uttar Pradesh, India, from 2000 - 3200 m elev. with *Abies*, *Cedrus*, *Picea*, *Pinus*, and *Quercus*; also reported from southwest China and Japan. .... *Amanita flavipes*.

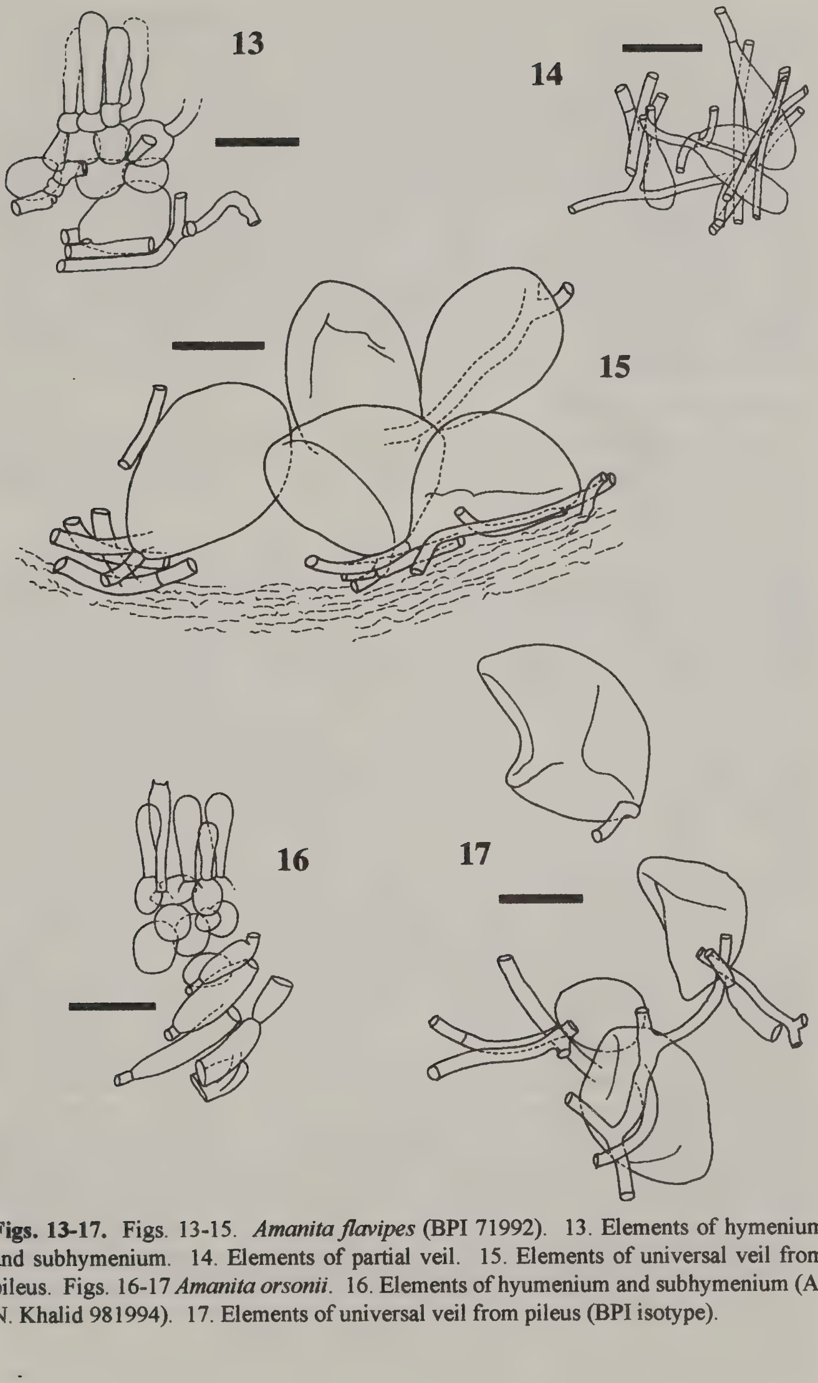
6. *AMANITA FLAVIPES* Imai. 1933. *Bot. Mag. (Tokyo)* 47: 428.

≡*Amplariella flavipes* (Imai) E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 79, tab. 47(fig. 3).
=*Amanita bella* (Imai *in* E. J. Gilb.) Imai *in* E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 47, tab. 47(fig. 4).
≡*Amplariella bella* (Imai *in* E. J. Gilb.) E. J. Gilb. 1940. *Iconogr. Mycol. (Milan)* 27, suppl. (1): 79.
≡*Amanita pulchella* Imai *nom. illeg.* 1933. *Bot. Mag. (Tokyo)* 47: 427.
non Amanita pulchella (Cooke & Massee) E. J. Gilb. 1941. *Iconogr. Mycol.* 27, suppl. (1): 203, tab. 1(fig. 1).
=*Amanita watlingii* Kumar & Lakhanpal *in* Kumar *et al.* 1990a. *Amanitaceae India*: 92, 112, fig. 18 (A-E).
=*Amanita flavoconia sensu* Kumar *et al. (p.p.)* 1990a. *Amanitaceae India*: 63, 99, fig. 5 (A-E).
non Amanita flavoconia Atk. 1902. *J. Mycol.* 8: 110.
=*Amanita flavorubescens sensu* Yuan & Sun. 1995. *Sichuan Mushrooms*: 495.
non Amanita flavorubescens Atk. 1902. *J. Mycol.* 8: 111.
Illus.: Gilbert. 1941. *Iconogr. Mycol. (Milan)* 27, suppl. (1): tab. 54, 55.
Illus.: Imazeki and Hongo. 1965. *Color. Illus. Fungi* 2: 41, pl. 12(fig. 75).
Illus.: Imazeki *et al.* 1988. *Fungi Japan*: 162.

Figs. 13-15

PILEUS: 30 - 100 mm wide, deep yellow to brownish yellow to deep orange (4-5A8, 5C8), sometimes with grayish yellow tones, globose to convex in younger basidiocarps, expanding to planoconvex or plane in age, faintly umbonate to umbonate, viscid when wet; *context* thin to moderately thick, soft to firm, white to yellowish white (3A2), sometimes light yellow just below pileipellis, unchanging when cut or bruised; *margin* nonstriate and decurved at first, uncurved to flaring upward and slightly striate in age; *universal veil* as yellow to deep yellow warts or floccose patches, mostly concentrated over disc, rare or absent at margin, detersile.

LAMELLAE: free to narrowly adnexed, crowded, yellowish white to light yellow



Figs. 13-17. Figs. 13-15. *Amanita flavipes* (BPI 71992). 13. Elements of hymenium and subhymenium. 14. Elements of partial veil. 15. Elements of universal veil from pileus. Figs. 16-17 *Amanita orsonii*. 16. Elements of hyumenium and subhymenium (A. N. Khalid 981994). 17. Elements of universal veil from pileus (BPI isotype).

(3A2, 4A4), edges entire, 3 - 6 mm broad, fleshy to brittle, thin; *lamellulae* of 2 to 4 lengths.

STIPE: 40 - 130 × 10 - 25 mm, light yellow to deep yellow (4A4, 4A8) above annulus, yellow to yellowish white below, smooth, sometimes with cracking pattern girdling stipe especially in its upper half, narrowing upward slightly; *context* pale white, sometimes yellow under stipipellis, unchanging when cut or bruised, solid to stuffed when young, becoming hollow in age; *bulb* small, occasionally ovoid, often obconic to somewhat radicating; *partial veil* superior, membranous, thin to moderately thick, skirt-like, collapsing on stipe, yellowish white to yellow to deep yellow (sometimes browner or more sordid than universal veil in age), striate above, with edge thickened by fragments of universal veil; *universal veil* as friable patches and fine line or lines encircling bulb above broadest part, yellow to orangish or brownish yellow, largely detersile, easily left in substrate during collection.

Odor and *taste* not distinctive.

MACROCHEMICAL TESTS [*per* Kumar *et al.* (1990a)]: Aniline water - negative or pinkish red on pileipellis, pinkish red on pileus context. 2% aqueous phenol - negative on pileipellis, reddish on pileus context.

PILEIPELLIS: 80 - 180 (-195) μm thick, with colorless gelatinized suprapellis minimal to 20 - 45 μm thick, with subpellis 60 - 150^+ μm thick mostly colorless but sometimes yellow to orange-yellow at interface with pileus context in region $5^\pm$ - 45 μm thick; filamentous, undifferentiated hyphae 2.5 - 6.5 μm wide, branching, dominantly subradially arranged but with plentiful criss-crossing fascicles; vascular hyphae 4.0 - 11.4 μm wide, occasionally branching, infrequent, more sordid or browner than surrounding hyphae, sinuous to twisted. PILEUS CONTEXT: filamentous, undifferentiated hyphae 1.5 - 5.5 μm wide, with occasionally slightly inflated intercalary segments up to 7.0 μm wide, singly and in fascicles, interwoven in open lattice structure, plentiful to dominating; acrophysalides plentiful, thin-walled, subpyriform to broadly clavate to clavate, up to 91 × 29 μm; vascular hyphae 4.5 - 19.7 μm wide, occasional, sinuous, sordid orangish yellow. LAMELLA TRAMA: bilateral; central stratum not rehydrating in material examined; subhymenial base poorly rehydrating in paratype of *A. watlingii*, including partially inflated to inflated intercalary cells subfusiform to clavate to broadly clavate (up to at least 41 × 20 μm); filamentous undifferentiated hyphae 2.0 - 7.0 μm wide; vascular hyphae not observed. SUBHYMENIUM: pseudoparenchymatous when fully inflated, comprising $3^\pm$ irregular ranks of inflated cells below bases of longest basidia, with inflated cells subglobose to ellipsoid (*e.g.*, 6.0 × 6.0 μm immediately below basidia; *e.g.*, 17.0 × 13.0 μm in middle ranks; *e.g.*, 30 × 23 μm in rank nearest central stratum), with basidia arising from inflated cells. BASIDIA: 29 - 41 × 7.2 - 10.5 μm, thin-walled, 4-sterigmate, with sterigmata up to 4.5 × 1.2 μm; no clamps observed. UNIVERSAL VEIL: *On pileus*: upper part of warts missing in paratype of *A. watlingii*; all elements above basal portion having subanticlinal to anticlinal orientation at first, becoming disordered with age; filamentous, undifferentiated hyphae 1.4 - 6.0 μm wide, branching, sometimes contricted at septa, dominating and with periclinal orientation in region immediately above pileipellis (Fig. 15), otherwise plentiful and with subanticlinal orientation; inflated cells dominating above very base, terminal in chains of up to three cells, thin-walled, in lower portion of warts globose to subglobose to subpyriform to ovoid to ellipsoid and up to 58 × 42 μm, in upper portion of warts subfusiform to clavate to broadly clavate to ellipsoid to ovoid to subglobose and up to 83 × 61 μm, dominantly colorless but often with yellow walls, with walls dominantly thin but infrequently up to 1.0 μm thick; vascular hyphae infrequently crossing boundary from pileipellis and like those described for that tissue. *On stipe base*: not observed in paratype of *A. watlingii*, absent or extensively gelatinized in all material examined; filamentous, undifferentiated hyphae in fascicles, common; inflated cells dominating, broadly fusiform to ellipsoid to ovoid to pyriform to subglobose, up to 69 × 52 μm; vascular hyphae not observed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 2.5 - 6.9 μm wide, branching, plentiful, singly and in fascicles; acrophysalides thin-walled, dominating, up to 330 × 32 μm; vascular hyphae 6.4 - 10.3 μm wide, sinuous, infrequent. PARTIAL VEIL: filamentous, undifferentiated hyphae 1.9 - 3.8 μm wide, commonly branching, singly and in fascicles, on upper surface organized in moderately widely spaced subradially arranged fascicles with some criss-crossing fascicles, in interior disordered and loosely interwoven; inflated cells thin-walled, scattered, terminal, occasionally with slightly inflated subterminal segment, clavate, up to 44 × 16.5 μm; vascular hyphae not observed.

BASIDIOSPORES: [145/7/5] (6.0-) 6.8 - 8.5 (-11.0) × (5.0-) 5.2 - 6.5 (-8.8) μm, (**L** = 7.3 - 7.7 (-7.8) μm; **L'** = 7.5 μm; **W** = 5.7 - 5.9 μm; **W'** = 5.8 μm; Q = (1.12-) 1.16 - 1.49 (-1.69); **Q** = 1.27 - 1.34 (-1.38); **Q'** = 1.30), hyaline, colorless, thin-walled, smooth, amyloid, broadly ellipsoid to ellipsoid, occasionally subglobose or elongate, often adaxially flattened, sometimes swollen at one end; apiculus sublateral, cylindric, narrow, sometimes prominent; contents mono- or multiguttulate, with or without additional small granules; white in deposit.

Habitat and distribution: Solitary to gregarious, in mixed woods, mostly under conifers. Himachal Pradesh, India [Kumar *et al.* (1990a)]: At 2000 to 3200 m elev. In woods of *Cedrus deodara*, *Picea smithiana* and *Abies pindrow* or woods of *C. deodara* and *Pinus wallichiana* or under *C. deodara* or in dominantly coniferous forest of *C. deodara* and *P. wallichiana* with scattered *Quercus incana*. *Pakistan: With A. pindrow*.

Kumar *et al.* (1990b) investigated four ecological zones at elevations from 1829 to 3048 m elev. in Himachal Pradesh and found "*A. flavoconia*" (almost certainly *A. flavipes*) in all zones. They further reported tracing ectomycorrhizal connections of "*A. flavoconia*" to *C. deodara*. Abraham & Kachroo (1989) report "*A. flavoconia*" with spores and macroscopic characters similar to those of *A. flavipes* from duff under *P. smithiana* and *A. pindrow* in cespitose clusters at 2700 m in Jammu and Kashmir.

Collection examined: **PAKISTAN**: N. W. FRONTIER PROV.—Nathiagali, Kuzagali, 7.viii.1994 A. N. Khalid 781994 (LAH; RET).

Extralimital collections examined: **INDIA**: HIMACHAL PRADESH—Chamba - Kala Top, 16.viii.1985 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 3324 as "*A. flavoconia*"). Kullu - Manali, 11.viii.1985 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 3176 (*n.v.*) & BPI 71985 as "*A. flavoconia*"). Shimla - Chopal, 29.ix.1985 T. N. Lakhanpal & A. Kumar *s.n.* (paratype of *A. watlingii*, HPUB 3619 (*n.v.*) & BPI 71992). UTTAR PRADESH—Garhwal, Nagdeva-Jhandidhar, 23.viii.1993 V. K. Bhatt & R. P. Bhatt *s.n.* (GUH M-20069 as "*A. flavoconia*"; RET).

DISCUSSION

Amanita flavipes is known to occur with *Picea* and *Pinus* in China (Sichuan, Yunnan), Japan, and Tibet. Yang (1997: 202-206, figs. 169-172) has reported on *A. flavipes* in more detail than any previous author and provided an excellent account of the anatomy of that species and a list of proposed taxonomic synonyms. This list does not include *A. watlingii*. However, Yang's description is extensive; and our material conforms to it very closely. Hence, we propose that *A. watlingii* is a taxonomic synonym of *A. flavipes*.

Phenetically, the most similar taxon is *A. flavoconia* var. *inquinata* Tulloss, Ovrebo & Halling (1992b). It is known from *Quercus humboldtii* Bonpl. forest (1900 - 2500 m elev. or higher) in Colombia, *Quercus* cloud forest in Costa Rica, and *Pinus-Quercus* forest in the neovolcanic axis of Mexico (Tulloss, unpub. data), and may extend further northward in association with *Quercus*. The spores of *A. flavoconia* var. *inquinata* are slightly larger and rounder than those of *A. watlingii* (Tulloss, unpub. data). Spores of *A. flavoconia* var. *inquinata* are [665/32/13] (5.2-) 6.8 - 9.0 (-11.5) × (4.5-) 5.8 - 7.5 (-9.5) µm, with **Q** = (1.12-) 1.14 - 1.28 and with **Q'** = 1.20. Among additional characters of *A. flavoconia* var. *inquinata* that separate the two taxa are the following:

- lamella trama containing plentiful vascular hyphae,
- inflated cells of lamellae trama up to 109 × 63 µm,
- a pileus which is often orange-brown to fulvous (6-7E8)—considerably darker than that in *A. watlingii*,
- a stipe which is often of a more orange or orange-brown hue than is described for *A. watlingii*.

Tulloss *et al.* (1992b) provide a discussion of taxa phenetically similar to *A. flavoconia* var. *inquinata*.

The cracking of the stipipellis in concentric circles, as noted in the protologue of *A. watlingii*, is not at all uncommon in *A. flavoconia* var. *flavoconia* and numerous other species in all sections of *Amanita*; we are inclined to say that this character is not of taxonomic value.

One of the collections cited as "*A. flavoconia*" by Kumar *et al.* (1990) is apparently mixed and includes at least one pileus of a species with inamyloid spores. This collection is cited as "HPUB 4098"; however the correct collection number is "1098". Portions of this material are presently in GUH, HPUB, and RET.

7. *AMANITA ORSONII* Kumar & Lakhanpal *in* Kumar *et al.* 1990a. *Amanitaceae India*: 75, 105, fig. 11 (A-E).

=?*Amanita rubescens sensu* Imazeki & Hongo. 1965. *Color. Illus. Fungi* 2: 42, pl. 13(fig. 77).

=?*Amanita rubescens sensu* Imazeki *et al.*. 1988. *Fungi Japan*: 162-163.

=?*Amanita excelsa sensu* Abraham & Kachroo. 1989. *Micol. Neotrop. Apl.* 2: 43, fig. 5.

non Amanita excelsa (Fr.:Fr.) Bertillon *in* DeChambre. 1866. *Dict. Encycl. Sci. Med.* 1(3): 499.

=?*Amanita rubescens sensu* Abraham & Kachroo. 1989. *Micol. Neotrop. Apl.* 2: 49, figs. 16-17.

non Amanita rubescens (Pers.:Fr.) Pers. 1797. *Tent. Disp. Meth. Fung.*: 67.
=*Amanita rubescens sensu* Kumar *et al.* 1990a. *Amanitaceae India*: 82, 108, fig. 14 (A-E).
non Amanita rubescens (Pers.:Fr.) Pers. 1797. *op. cit.*

Figs. 16-17

PILEUS: 20 - 110 mm wide, color prior to bruising not recorded, orange-red (close to 7A6) to grayish red to reddish brown (8C4, 8E4) to grayish brown (6E3), color darker in disc or having light brown tinge (6D4) in disc, color fading slowly toward margin and there orangish cream in youngest material for which notes exist, brown to fuligineous in exsiccata, fleshy to fragile, globose to ovoid to convex when young, becoming broadly convex to planoconvex to plane with age, sometimes with low broad umbo, viscid to slightly viscid when wet; *context* thin (confirmed in exsiccata even near stipe), white, staining reddish with age or on injury, with color appearing slowly after cutting or bruising, soft; *margin* regular, decurved, nonstriate at first, becoming faintly striate with aging, sometimes rimose in mature specimens, with slight sterile rim extending beyond lamellae in one specimen; *universal veil* as floccose, flat, polygonal scales and warts, white at first, grayish brown at maturity, at least sometimes more plentiful near pileus margin than over disc.

LAMELLAE: free to narrowly adnexed, close to crowded, white to yellowish white to grayish, staining red to grayish red in age or when bruised as in other parts of the basidiocarp, up to 10 mm broad, thin, fleshy to brittle, edges entire; *lamellulae* sometimes rounded truncate (shortest), of diverse lengths, unevenly distributed.

STIPE: 35 - 150 × 8 - 30 mm, pallid with pink to red blotches to reddish white to grayish red to grayish brown, narrowing upward, pruinose at apex, smooth to fibrillose and longitudinally striatulate below partial veil, fibrils becoming reddish brown and appressed; *context* white, staining reddish to grayish red on injury, particularly in the base, solid when young, becoming hollow with age; *bulb* up to 15^+ mm wide; *partial veil* superior to submedian, probably slipping down stipe somewhat with age, membranous, thin to moderately thick, white to off-white to reddish white to reddish gray to grayish red, proportionately short, skirt-like, eventually collapsing on stipe, sometimes splitting radially; *universal veil* inconspicuous, friable, ephemeral or leaving few white to grayish white to grayish red to reddish brown patches adhering loosely to bulb or in soil around bulb.

Odor and *taste* not distinctive.

MACROCHEMICAL TESTS: Aniline water - reddish brown on pileus context. Conc. HNO_3 - yellow to light yellow on pileus context. 2% aqueous phenol - reddish brown on pileus context. All three reagents - negative on pileipellis.

PILEIPELLIS: $85^{\pm}$ μm thick, gelatinizing only at surface (gelatinized layer is barely more than one hyphal diameter in thickness and colorless), predominantly ungelatinized, yellow-brown to brownish yellow or brownish orange, apparently somewhat collapsed/compressed in some material of isotype; filamentous, undifferentiated hyphae 1.3 - 8.9 μm wide, branching, singly and in fascicles, somewhat loosely interwoven, over disc without dominant orientation and with gaps in layers making layering obvious from above, dominantly subradially arranged near margin, but there also with criss-crossing fascicles; vascular hyphae 4.8 - 15.1 μm wide, infrequently branching, sinuous, with occasional loose or rather tight coils, unevenly distributed, scattered to locally plentiful and in tangles. PILEUS CONTEXT: partially collapsed and damaged in isotype; filamentous, undifferentiated hyphae 3.8 - 10.8 µm wide, branching, plentiful, singly or in narrow fascicles, interwoven in open lattice structure, sometimes with subrefractive yellowish walls; acrophysalides plentiful, pyriform to broadly clavate (*e.g.*, 69 × 34 µm in isotype), thin-walled; vascular hyphae not observed in isotype, but possibly penetrating adjacent trama somewhat from pileipellis. LAMELLA TRAMA: bilateral, badly damaged collapsed and even partially gelatinized in isotype; central stratum distinct, apparently dominantly comprising filamentous, undifferentiated hyphae, with some inflated intercalary subfusifrom segments up to 15.5 µm wide; subhymenial base containing inflated cells [often intercalary, ovoid to ellipsoid to broadly clavate to narrowly clavate to subfusiform, up to 61 × 22 (-30?) µm]; filamentous, undifferentiated hyphae 1.5 - 6.8 µm wide, branching; divergent, terminal inflated cells not definable due to state of tissue in isotype, similar in form to intercalary cells of subhymenial base if present; vascular hyphae not observed. SUBHYMENIUM: badly damaged, collapsed, and even partially gelatinized in isotype; pseudoparenchymatous, with small globose to subglobose to ellipsoid inflated cells (up to 16.0 × 13.8 µm) in 3 to 5 irregular ranks below base of longest basidia, with basidia arising from inflated cells. BASIDIA: 25 - 44 × 6.0 - 14.0 µm, 4-, infrequently 1-sterigmate, thin-walled, with sterigmata up to 4.0 × 1.5 µm; no clamps observed. UNIVERSAL VEIL: *On pileus*: elements sometimes showing some vertical orientation, often disordered; filamentous, undifferentiated hyphae 3.6 - 5.1 µm wide, branching, plentiful; inflated cells dominating, thin-walled, colorless or faintly yellowish, yellow-orange to brownish orange in mass, globose to pyriform to ellipsoid to clavate, up to 85 × 55 µm, at least partially collapsed; vascular hyphae not observed, but tissues badly collapsed in all specimens reviewed. *On stipe base*: elements disordered; filamentous, undifferentiated hyphae 1.9 - 6.4 µm wide, branching, singly and in fascicles, common, more frequent than on pileus; inflated cells plentiful, similar in shape to those on pileus, collapsed and partially gelatinized, pale sordid orange-yellow to orange-brown, up to 67 × 53 µm, singly and in chains of up to 3 cells; vascular hyphae not observed, but tissues badly collapsed in all specimens reviewed. STIPE CONTEXT: longitudinally acrophysalidic; filamentous, undifferentiated hyphae 1.5 - 10.3 µm wide, branching, plentiful, dominating near stipe surface, with occasional intercalary partially inflated segments up to 17.8 µm wide; acrophysalides plentiful to dominant except near stipe surface, up to 248 × 55 µm, shorter and proportionately broader near surfaces, with walls thin or slightly thickened (less than 0.5 µm thick); vascular hyphae (4.1-) 6.2 - 17.8 (-20) µm wide, occasionally branching, sinuous, unevenly distributed, scattered to locally common, at times loosely to rather tightly coiling, sordid yellow. PARTIAL VEIL: gelatinized on upper surface in isotype; filamentous, undifferentiated hyphae 1.5 - 6.5 µm wide, branching, singly and in fascicles, interwoven in moderately dense lattice, but dominantly (or very nearly dominantly) subradially oriented; inflated cells not identifiable with certainty (except for bits of volva or lamella marginal cells) in isotype; vascular hyphae 3.6 - 9.1 µm wide, sinuous, infrequent, unevenly distributed, pale sordid yellow-orange.

BASIDIOSPORES: [153/7/5] (6.5-) 7.0 - 9.2 (-10.5) × (5.0-) 5.5 - 7.0 (-8.0) µm, (**L** = 7.7 - 8.3 (-8.8) µm; **L'** = 8.2 µm; **W** = 5.9 - 6.3 (-6.7) µm; **W'** = 6.2 µm; Q = (1.13-) 1.16 - 1.50 (-1.58); **Q** = 1.23 - 1.34 (-1.39); **Q'** = 1.31), hyaline, colorless, thin-walled, smooth, amyloid, broadly ellipsoid to ellipsoid, infrequently subglobose, often adaxially flattened, often expanded at one end; apiculus sublateral, small, cylindric; contents monoguttulate to multiguttulate to granular; white in deposit.

Habitat and distribution: Solitary to scattered to gregarious. Himachal Pradesh, India [*per* Kumar *et al.* (1990a)]: At 2300 - 2700 m elev. Under *Cedrus deodara* (in mixed woods or as solitary tree) or under *Quercus incana* or under *Q. incana* and *Pinus wallichiana*. Uttar Pradesh, India: Under *Cedrus* or near *Q. lanata* Sm. (=*Q. leucotrichophora* A. Camus) and *Rhododendron arboreum*. Pakistan: Associated with *Cedrus deodara*.

Kumar *et al.* (1990b) found "*A. rubescens*" in the highest two ecological zones they investigated in Himachal Pradesh (2438 - 3048 m elev.). They also reported tracing ectomycorrhizal connections from "*A. rubescens*" to *C. deodara* and *Q. incana*.

Collection examined: **PAKISTAN**: N.W. FRONTIER PROV.—Hazara Distr. - Kuzagali,.8.viii.1994 A. N. Khalid 981994 (LAH; RET).

Extralimital collections examined: **INDIA**: HIMACHAL PRADESH—Kullu - Manali, 11.viii.1985 T. N. Lakhanpal & A. Kumar *s.n.* (holotype, HPUB 3188 (*n.v.*); isotype, BPI 71991). Shimla - Baghi, 14.viii.1983 T. N. Lakhanpal & A. Kumar *s.n.* (HPUB 511 (*n.v.*); BPI 71988 as "*A. rubescens*"). UTTAR PRADESH—Chamoli - Bhatwari, 22.viii.1990 V. K. Bhatt & R. P. Bhatt *s.n.* (GUH M-19656; RET); Garhwal - *ca.* Ransi Stadium, 4.viii.1993 V. K. Bhatt & R. P. Bhatt *s.n.* (GUH M-20033; RET).

DISCUSSION

All the material reviewed had imperfectly preserved tissues in three critical areas: the lamella trama, the universal veil, and the partial veil. Hence, this species should be considered incompletely known and its relationship with other rubescent taxa in section *Validae* must be reviewed when better material is obtained.

Tulloss (unpub. data) has examined a number of collections of *A. rubescens* from northern Europe and believes that *A. orsonii* is distinct from the European *A. rubescens*. While the structure of their subhymenia are clearly related, the inflated cells in the sybhymenium of *A. rubescens* are larger than those seen in the subhymenium of *A. orsonii*. The spores of *A. rubescens* are considerably longer and narrower than those of *A. orsonii*. Comparison of *A. orsonii* to a number of other rubescent taxa can be derived from data presented by Tulloss and Lindgren (1994).

A photograph of the Pakistani collection of the present species strongly suggests the watercolor painting of *A. rubescens sensu* Imazeki & Hongo (1965) and the photographs of the same species in (Imazeki *et al.*, 1988). The penant-shape of the universal veil warts near the margin of the pileus, the orange-pink tint of the flesh of the young stipe, the strong red of the pileus in youth, and the small size of the superior partial veil in the Japanese illustrations all are very similar to the same characters as seen in our photograph. Imazeki *et al.* (1988) give the spore size for the Japanese material as 8 - 9.5 × 6 - 7.5 µm (est. **Q** = 1.30)—much more similar to the data from *A. orsonii* than to the data from northern European specimens of *A. rubescens*.

The spore measurements given by Abraham and Kachroo (1989) for "*A. rubescens*" may contain a typographical error with regard to width; for the measurements suggest subglobose spores while the text states that the spores are "short-ellipsoid to subovoid."

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MYCOTAXON

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TWO NEW SPECIES OF NEPHROMOPSIS (PARMELIACEAE, ASCOMYCOTA)*

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Abstract: Two new species, *Nephromopsis weii* X. Q. Gao & L. H. Chen and *N. hengduanensis* L. H. Chen, collected from China are described in this paper.

Key words: *Nephromopsis*, new species, China

In the course of preparation of the lichen flora of China "Flora Lichenum Sinicorum", the taxonomic study of cetrarioid lichen-forming fungi was made. During the study two undescribed species were found in the materials collected by X. Q. Gao from Fujian province and by X. Y. Wang et al. from Yunnan province respectively.

The nephromoid apothecia of the two new species apparently indicate that they belong to a group of the following close genera: *Nephromopsis* Müll. Arg. revised by Randlane et al. (1995), *Cetreliopsis* Lai (M. J. Lai, 1980) and *Tuckneraria* Randlane & Thell (1994). The pseudocyphellae of the two new species suggest that they may be placed in *Cetreliopsis*. However, the globose ascospores and lack of fumarprotocetraric acid in the medulla of the new species *N. weii* show that it doesn't belong to *Cetreliopsis*, for all members of the latter have ellipsoidal ascospores and contain fumarprotocetraric acid in the medulla. The lack of fumarprotocetraric acid in medulla of *N. hengduanensis* denies the possibility of placing it in *Cetreliopsis* either. The pseudocyphellae of the two new species also deny the possibility of placing them in *Nephromopsis* Müll. Arg. revised by Randlane et al., whose members have pseudocyphellae only on lower surface.

The thinner thallus, greenish yellow upper surface and sparse ciliars along the margins of *N. hengduanensis* are typical of *Tuckneraria*. The ellipsoidal ascospores and pseudocyphellae of this new species, however, deny the possibility of placing it in *Tuckneraria*, for all members of the latter have globose or subglobose ascospores and lack pseudocyphellae on upper surface.

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* The subject supported by the National Natural Science Foundation of China (39899400).

From the above discussions, it is difficult for us to suggest which genera the two new species should be placed because they are the intermediate members of *Nephromopsis* Müll. Arg. revised by Randlane et al., *Cetreliopsis* and *Tuckneraria*. The existence of the intermediate members among three genera mentioned above means that the reasonability of the segregations of *Cetreliopsis* and *Tuckneraria* from *Nephromopsis* Müll. Arg.(1891) may be artificial, or that *Cetreliopsis*, *Tuckneraria* and *Nephromopsis* Müll. Arg. revised by Randlane et al. need to be further revised. Therefore, we decide to place the two new species in *Nephromopsis* Müll. Arg. in this paper.

The Latin diagnoses and descriptions both in Latin and English with four figures for the new two species are given in this paper. The lichen substances were detected by the TLC method (Culberson & Kristinsson, 1970; White & James, 1985).

Nephromopsis weii X. Q. Gao & L. H. Chen, sp. nov. (Fig. 1 & Fig. 3).

Species nova primo aspectu maxime similis *C. ciliaribus*, sed pseudocyphellis superficiebus ambabus thallorum.

Typus: Sina, in cortice Pini in monte Wuyi proviciae Fujianensis, 24/Ⅳ/1988, Xiangqun Gao, 7619 (HMAS-L, holotypus et UPS, isotypus).

Thallus foliaceus, moderatus, 4-6 cm latus, supra olivaceo-brunneus, laevis, nitidus, infra pallido-vel atro-brunneus, leviter rugosus, lobis 2-8 mm latis; pseudocyphellae in superficiebus ambabus thallorum; apothecia terminalia; discus reniformis, 5-15 mm latus; asci longe clavati; ascosporae 8, simplices, globosae, 6-7 μm diam.; pycnidia ad apicem projecturae loborum thallorum; pycnoconidia bifusiformia, 3.5-4.5 × 1.5 μm.

Etymology: Named in honor of the distinguished Chinese lichenologist Dr. professor Jiangchun Wei.

Thallus foliose, medium-sized, 4-6 cm broad; lobes 2-8 mm wide; upper surface olive-brown, smooth, shinny; lower surface pale to dark brown, slightly rugose; rhizines sparse, long, unbranched; pseudocyphellae on both upper and lower surfaces; soredia and isidia absent.

Both upper and lower cortices paraplectenchymatous, upper cortex 15-25 μm tall; medulla 38-60 μm tall; lower cortex 15-25 μm tall.

Apothecia on lower surface of lobe tips, more or less nephromoid; disc kidney-like, 5 × 15 mm; asci elongate-clavate; ascospores 8, simple, globose, 6-7 μm in diam.; pycnidia on the tip of projection; pycnoconidia bifusiform, 3.5-4.5 × 1.5 μm.

Chemistry: lichesterinic, protolichesterinic and caperatic acids.

Ecology and distribution: Growing on barks of conifer trees, present at high levels in the subtropical mountain of southeastern China. It is abundant and dominant in the certain elevation of the mountain.

Specimens examined: China, Prov. Fujian, Wuyi Mt., alt. 1800 m, April 24, 1988 Xiangqun Gao, 2761, 2787, and that without number (HMAS-L, paratypes).

The new species is characterized by the brown, shinny thallus with pseudocyphellae on both upper and lower surfaces. It somewhat resembles *Nephromopsis asahinae* morphologically, but its thallus color distinguishes it from the latter easily.

This species also has some common characters with *Cetraria ciliaris** complex, e.g. brown thallus, terminal apothecia, and globose ascospores, but all species in *C. ciliaris* complex lack pseudocyphellae on either surface, and are distributed in the boreal forests.

Nephromopsis hengduanensis L. H. Chen, sp. nov. (Fig. 2 & Fig. 4).

Species ascosporis maximis a congeneribus diversa.

Typus: Sina, in clivo orientali montis nivalis Biluoensis provinciae Yunnanensis, alt. 3350, 13/ Ⅶ /1982, Xianye Wang et al. 4507 (HMAS-L, holotypus).

Thallus foliaceus, moderatus, 3-5.5 cm latus, interdum ciliatu, superficiebus straminis, cum pseudocyphellis in submargine superficiebus et paginis inferis thallorum et cum rhizinis c. 3 mm longis. Apothecia nephromoidea; discus brunneus; sporae 8-nae, simpices, ellipsoidae, 12-17 × 29-35 μm. Pycnidia marginalia, verrucosa; pycnocondia bifusiformia, fififormia, 2.5 × 9 μm.

Etymology: The epithet word "hengduan" is the name of the mountain ranges from which the new species was collected.

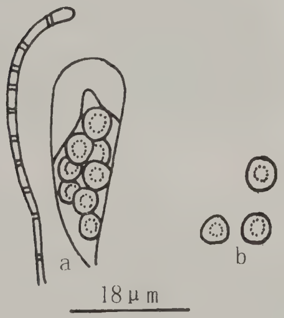

Fig. 1. *Nephromopsis weii*, a. an ascus containing eight ascospores, with a paraphysis, b. ascospores, Xiangqun Gao, 7619, holotype.

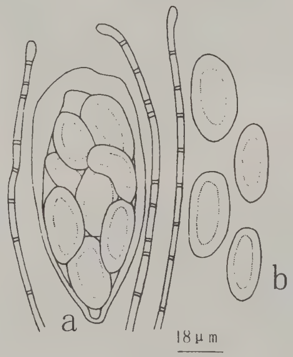

Fig. 2. *Nephromopsis hengduanensis*, a. an ascus containing eight ascospores, with paraphyses, b. ascospores, X. Y. Wang, et al. 4507, holotype.

Thallus medium-sized, foliose, 3-5.5 cm in diam., with lobes of 3-5 mm broad, ciliate occasionally, and marginally dark brown; upper surface smooth or slightly rugose, straw with all tints of brown; submarginally with a few pseudocyphellae, without isidia and soredia; lower surface brown to dark brown, with net ridges and pseudocyphellae in the form of patches mainly on ridges or plug-like outgrowths and submarginally with rhizines up to 3 mm long.

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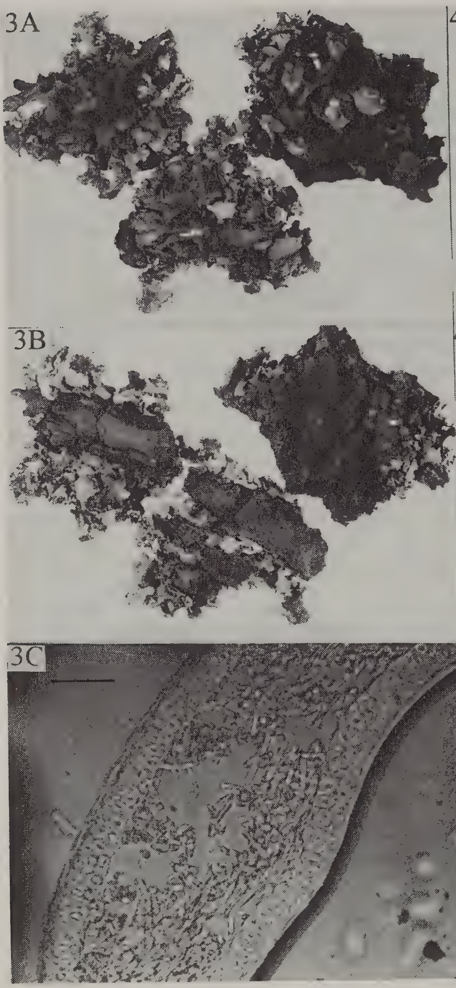
*According to our studies on the sequences of rDNA ITS of cetrarioid lichens, we are strongly inclined to think that the segregation of *Tuckermannopis* is too artificial. The results concerned will be discussed in a later paper.



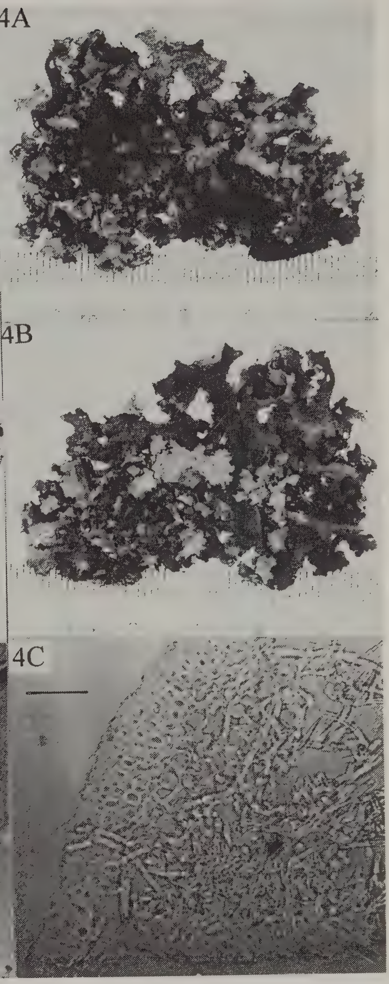


Fig. 3 *Nephromopsis weii* 3A. the upper surface of thallus, 3B. the lower surface of thallus, 3C. paraplectenchymatous cortex, X. Q. Gao, 7619, holotype. 3A and 3B scale in mm, bar in 3C=30 μ m.

Fig. 4 *Nephromopsis hengduanensis* 4A. the upper surface of thallus, 4B. the lower surface of thallus, 4C. upper paraplectenchymatous cortex, X. Y. Wang et al., 4507, holotype. 4A and B scale in mm, bar in 4C=30 μ m.

Thallus 200-230 μm tall, both upper and lower cortices of the thallus paraplectenchymatous; upper cortex 24-29 μm tall; algal layer 55-70 μm tall; medulla 80-100 μm tall; lower cortex 25-30 μm tall.

Apothecia on lower surface of lobe tips, reniform, with brown discs; discs 4-6 × 1-3 mm; epithecium 10-16 μm tall; hymenium 120-140 μm tall; hypothecium 28-40 μm tall; exciple 95 μm thick; asci very broadly clavate, 50-70 × 100-140 μm, octosporus with axial body of more than 6 μm broad; ascospores ellipsoid, 12-17 × 29-35 μm.

Pycnidia mainly marginal, in the black shinny warts; pycnoconidia bifusiform, 2.5 × 9 μm.

Chemistry: usnic, lichesterinic, protolichesterinic, olivetoric and caperatic acids.

Specimens examined: China, Prov. Yunnan, Lushui County: Pianma, Tingming Lake, alt. 2900 m, June 7, 1981, Xianye Wang et al. 2285; alt. 3350 m, June 7, 1981, Xianye Wang et al. 2669 (HMAS-L, Paratypes).

The new species is different from other members of *Nephromopsis* by its very long broad clavate asci and very big ellipsoidal ascospores.

Though *N. hengduanensis*, *Nephromopsis stracheyi* (chemotype Ⅰ) and *N. rugosa* (chemotype Ⅰ) have the similar C+ reaction, *N. hengduanensis* is distinguished by thinner thallus and containing caperatic acid in medulla from *N. stracheyi* which has thick thallus and lacks caperatic acid in medulla (Randlane & Saag, 1998), by relatively smooth surface and conspicuous bigger ascospores from *N. rugosa* which has strongly rugose surface and smaller ascospores (7-9 × 3-5 μm) (Randlane & Saag, 1998).

ACKNOWLEDGEMENTS

The authors would like to express their heartfelt thanks to Prof. J. C. Wei for his critical review of this paper, to Dr. Shouyu Guo for his thought provoking suggestions, to Prof. Yumei Jiang for her patient help on the line drawing, to Ms. Lancui Yuan for developing and printing the photographs, and to Ms Xiangfei Zhu for inking the line drawings.

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ONLINE RESOURCES FOR FUNGAL TAXONOMY and NOMENCLATURE:
Molecular Phylogenetics

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Maintainer, *WWW Virtual Library: Mycology*
http://mycology.cornell.edu/

Our ideas of fungal relationships have lately been profoundly influenced by DNA sequence information, and classification schemes have changed to reflect this new knowledge. The two sites below offer insight into how molecular and phylogenetic methods have shaped fungal classification. The Tree of Life site is a "phylogenetic navigator;" FungalWeb is a new site that links DNA characters with other attributes of fungi to produce an integrated phylogeny. Both are worth a visit.

Tree of Life	http://phylogeny.arizona.edu/tree/phylogeny.html
FungalWeb	http://srv129.novo.dk/fungalweb/

Entrez/GenBank

GenBank is a massive storehouse of publicly available nucleic acid sequence data, all annotated, linked to a literature database (PubMed), protein sequences and structures, and other information. These databases are conveniently searchable in several ways through Entrez, and sequences can be downloaded in any of several different formats. GenBank has significantly improved and updated its taxonomic system in recent years: try the Taxonomy Browser to locate a taxon by direct search or by following a hierarchical path. One can also submit a sequence to BLAST (Basic Local Alignment Search Tool) to retrieve similar sequences from the database (BLAST is based on pattern matching and is no substitute for a phylogenetic analysis). Most journals now require that sequences used in phylogenetic analyses be deposited in GenBank prior to publication: GenBank facilitates this process by providing the software utilities *Sequin* and *BankIt*.

Entrez	http://www.ncbi.nlm.nih.gov/Entrez/
BLAST search of GenBank	http://www.ncbi.nlm.nih.gov/BLAST/

Ribosomal DNA has formed the backbone of most fungal molecular phylogenetics projects thus far. The following two sites focus specifically on these molecules, and provide aligned data sets and structural information.

rRNA web server	http://rrna.uia.ac.be/
Ribosomal Database Project	http://www.cme.msu.edu/RDP/html/index.html

Sequence alignment

A first step in any phylogenetic analysis is alignment of the gene sequences that form the data set. Positional homologies inferred in the course of this process can profoundly affect the outcome of the analysis, so choices made here are of critical importance. Many different methods of multiple sequence alignment are available: some online, some as standalone software. The BCM Alignment site given below offers several online choices to get you started, other software can be found through Felsenstein's software listings (see below).

Baylor College of Medicine Multiple Sequence Alignment Server
http://dot.imgen.bcm.tmc.edu:9331/multi-align/multi-align.html

Despite the importance of alignment, journals are increasingly reluctant to publish alignment files due to space limitations. TreeBASE is an elegant solution to this problem: an online database that archives multiple alignment files and accompanying phylogenetic trees.

TreeBASE http://www.herbaria.harvard.edu/treebase/

Phylogeny inference

Molecular phylogenetic techniques have become important tools in the belts of taxonomic mycologists. Some of the requisite software is available at no cost on the internet; most users will want to purchase a software package for serious analyses. There are many freeware, shareware, and commercial software packages to generate, analyze, compare, and manipulate phylogenetic trees. J. Felsenstein, author of *PHYLIP*, aptly synthesizes these.

Phylogeny Programs (J. Felsenstein) http://evolution.genetics.washington.edu/phylip/software.html

The means by which relationships among DNA sequences should best be inferred is controversial; many important theoretical issues underlie the appropriate choice of a method of interference. Those new to phylogenetic analysis will find good introductory primers in M. Siddall's phylogenetic methods page, or the Molecular Systematics of Microorganisms course site of the Natural History Museum. The latter includes a useful glossary of the terminology of phylogenetic analysis.

Phylogenetics: just methods http://research.amnh.org/~siddall/methods/
Molecular systematics and evolution of microorganisms http://www.bioinf.org/molsys/

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BOOK REVIEWS AND NOTICES[1]

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GENERAL

Molecules, Morphology and Classification: Towards monophyletic genera in the ascomycetes. Edited by Keith A. Seifert, Walter Gams, Pedro W. Crous, and Gary J. Samuels. 10 May 2000. [Studies in Mycology No. 45.] Centraalbureau voor Schimmelcultures, Baarn/Delft, The Netherlands. Pp. 230. ISBN 90-70351-41-2; SISO 587 UDC 582.2.3. Price: NLG 100.00.

What a joy it is to be able to bring this work to the attention of readers, for no mycologist (or phytopathologist!) should ignore this exceptionally useful and provocative volume. The rule of thumb that most published symposia and workshop proceedings are not worth publishing is hereby irreparably broken. These 19 papers are 'based on contributions' to the symposium on 'The genus for genus concept' at the XVI International Botanical Congress and to the workshop on 'Molecules, morphology and classification: Towards monophyletic genera in the ascomycetes' at the IX International Congress of Mycology. The texts have been meticulously re-edited to make a comprehensive, readable, interdependent whole. Basidiomycete or zygomycete workers who overlook this book because the title seems to imply that ascomycetes are the subject are forewarned: much here is of great importance to you, too. The ascomycetes may be the focus, but the implications for taxonomy and nomenclature of all pleomorphic fungi are at stake.

This volume is for the older generation of morphotaxonomists anxious to understand the newest developments in classification, as well as for the brightest of our young scientists at the cutting edge of molecular work. Under no circumstances should anyone skip the editors' four page Introduction, with its exceptionally useful setting of the stage and their provision there of a glossary of some cladistic terms used in the volume. Similarly, note their 'Examples of anamorph names known to be phylogentically paraphyletic or polyphyletic, but that can be used a descriptive nouns'. They have adopted an editorial convention in which such nouns are neither capitalized nor italicized, e.g., acremonium, cladobotryum, fusarium, graphium, penicillium, etc., when 'used in a strictly monomorphic, form sense'. Definitions of these terms are provided in an Appendix to the Introduction.

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[1] Books for consideration for inclusion in this column should be sent to the Book Review Editor at his permanent address and not to that in Madrid: David L. Hawksworth, MycoNova, 14 Finchley Lane, Hendon, London NW4 1 DG, UK; tel/fax [+44] (0) 20 8203 4282; e-mail myconova@btinternet.com. Unsigned reviews and notices are by the Book Review Editor.

That all mycological systematics aims at reflecting phylogeny is clear, but the intricacies of multiple spore forms that each fungal species may possess has caused us to evolve a contorted nomenclature to deal with the anamorphs and teleomorphs (and, indeed, the holomorphs) we see. The rapid change in systematics with the rise of molecular techniques and the development of cladistic analyses now forces us to reexamine our International Code of Botanical Nomenclature. We must rethink our positions on the usefulness of more than one valid name for an organism, with each morph currently allowed a separate name under our Code. Integration of anamorphs and their related teleomorphs into one classification is inevitable and essential if a system reflecting phylogeny is our goal. Some anamorphic genera appear to be related to only one teleomorphic genus. Here a one-to-one classification is clear. But many genera of anamorphs appear in widely disparate positions in the ascomycete classifications. Therein lies the difficulty for both taxonomy and nomenclature, addressed so clearly in this volume.

The Code's Article 59 deals specifically with the anamorph/teleomorph problem, but despite its many fiercely argued modifications over the years it has clearly outlived its usefulness in modern systematics. In one of the most controversial articles in this volume, Paul F. Cannon's and Paul M. Kirk's "The philosophy and practicalities of amalgamating anamorph and teleomorph concepts," the call to action is clear: 'Deletion of Article 59 is inevitable in the long term, and it will be in the interests of nomenclatural stability (and therefore of all systematics practitioners) to prepare for this event'. I would add that since Article 59 has always failed to provide for the nomenclatural problems of fungi with synanamorphs, this is yet another reason that we must discard this tortured, impractical part of the Code. Cannon and Kirk challenge the primacy of teleomorph names over anamorph names, sometimes defensible, sometimes not. Their arguments deserve the serious attention of fungal nomenclaturalists.
Philosophical considerations are a huge element in this volume. Keith A. Seifert's and Gary J. Samuel's 'How should we look at anamorphs?' is required reading for anyone who deals with pleomorphic fungi. They bring together the diverse and scattered results of many authors who have had to deal with these problems (here and elsewhere in the volume often fungi in the Hypocreales, Clavicipitales, and Eurotiales, in which their expertise is seemingly boundless). To the same end, Amy Y. Rossman contributes her succinct analyses in 'Towards monophyletic genera in the holomorphic Hypocreales'

Space does not allow comment on all the individual papers included, but each has merit and opens new questions, and should be examined. Five of these that I have not already mentioned focus on Hypocreales and Clavicipitales. Two are devoted to Mycosphaerella and its anamorphs (G. J. M. Verkeley and M. J. Priest bring us up to date on the—insoluble?—problems of generic distinction of Septoria, Phloeospora, and Stagonospora). The anamorphs of Botryosphaeria, Capronia, and of Chaetosphaeria are similarly explored. Other papers focus on Graphium, Phialophora, Aspergillus, and Chalara (and their teleomorphs). Six new genera and 19 new species and new combinations are proposed. An index to fungal names is fortunately also included.

No library accessed by workers on fungi can afford to be without this immensely valuable resource.

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Illustrated Dictionary of Mycology. By Miguel Ulloa & Richard T. Hanlin. 2000. American Phytopathological Society Press, 3340 Pilot Knob Road, St Paul, MN 55121-2097, USA. Pp. 448, figs 1322. ISBN 0 89054 257 0. Price US $ 99.

It has been a frustration that some of the reference works with which Miguel Ulloa has been involved, for instance El Reno de Los Hongos: micología básica y aplicada (1990; with T. Herrera) and Etimología e Iconografía de Géneros de Hongos (1994; also with T. Herrera), have not been available in English. This new text from APS Press, however, rectifies the situation for another book, the Diccionario Illustrado de Micología, first published in Spanish in 1991. Over 3800 terms are not only defined but provided with etymological details. The illustrations comprise 548 line drawings and 774 half-tone photographs. Mycologists are often criticized for having too much jargon, but where that jargon adds precision in communication it is not to be automatically ruled out. The key is having access to clear definitions, and the visible presence of this work on the laboratory as well as the library shelves has the potential to be of major assistance here. It can serve as a complement to the 8th edition of Ainsworth & Bisby's Dictionary of the Fungi (1995) not only because of the numerous illustrations, but as it includes some terms not in that Dictionary !

At the back of the book there is an outline classification in which the positions of genera mentioned in the text are included. While this is consequently not a comprehensive overview in the detail found in Ainsworth & Bisby's Dictionary, it does include many of the most commonly encountered fungal genera. However, I was sad to see 'Deuteromycetes' appear, albeit with an explanatory by-line, but pleased that Eriksson & Winka's 1997 system for the ascomycetes was added as an 'appendage' for comparative purposes.

It is inevitable in a work of such breadth that it is more authoritative in some areas than others. From my own experience in compilatory works, I am sure that some mistakes found here (e.g. claiming Xanthoria elegans [as 'Caloplaca elegans'] as 'endolithic' when it is foliose or at most placodioid) could have been avoided by having a larger number of specialists check definitions related to different groups; that is something the authors might consider in a future edition. My main disappointment was the quality of many of the photographs, certainly due to their being largely made from coloured transparencies; that, and the use of colour, are additional aspects to consider in future editions.

Mycology Reference Cards. By Robert K. Noyd. 2000. American Phytopathological Society Press, 3340 Pilot Knob Road, St Paul, MN 55121-2097, USA. Cards 8, figs ca 120. ISBN 0 89054 261 9. Price US $ 29.

This set of eight hole-punched laminated cards provides an overview of the classification of fungal groups, largely based on the system adopted in the fourth edition of Introductory Mycology (Alexopoulos, Mims & Blackwell 1996). Each is devoted to one phylum and is presented as a hierarchical tree on which the features of classes, orders, etc, are given; examples of included genera are added and line illustrations provided of some representative orders. The reverse of each card consists either of a glossary of terms related to that phylum, or to a particular topic – as that on the holomorph (anamorph-teleomorph) concept. As in the case of the Illustrated Dictionary (see above) the conidial fungi caused problems. Here they are presented as a separate phylum Deuteromycota with classes and orders; I appreciate the problems and note that the author was well aware of the artificiality of the approach but is this really the 'way to organize and learn these fungi' as he states in the 21st century ? In a similar vein, do we still need to have a Gasteromycetes (in any case spelled incorrectly here as 'Gastromycetes') even if acknowledged as polyphyletic, an Aphyllophorales, or an Agaricales which includes Russulales ? The illustrations for some phyla were prepared specially by the author for this work and they are to a much higher standard than those copied from already published works. Could not a better source of illustrations of conidial fungi than Illustrated Genera of Imperfect Fungi (Barnett & Hunter, 1998) be found ? There are also some inconsistencies between data elements included, and I would have liked to see information on ecology and species numbers on all in the style adopted for the card on Chytridiomycota. Despite these concerns, here is a set of robust cards that can be used, although with a little caution, by both teachers and students, as a form of quick reference to have at hand during practical diagnostic or identification sessions in the laboratory.

A Check-list of the Mycological Flora of Madonie Park (North Sicily). Edited by Giuseppe Venturella, Alessandro Saitta & Salvatore La Rocca. July 2000. Mycotaxon Ltd, P.O. Box 264, Ithaca, NY 14851-0264, USA [Order from Ente Parco delle Madonie, Corso Paola Agliata 16, 90027 Petralia Sotana (Palermo), Italy.] Pp. 246, many maps. ISBN 0 930845 10 2. Price not indicated.

This treatment in English is a major contribution to our knowledge of the fungi of this part of northern Sicily. The Madonie territory covers 40K ha, and 551 basidiomycetes and 63 ascomycetes were found in surveys commissioned in 1995. Prior to this study, only 65 fungi (including microscopic species) had been reported from the territory. For each species, a strip-block system is used to provide an immediate impression of seasonality, and details of the habitats, altitudes, and particular localities are provided. Maps show the occurrences of species using a grid system. The species total is commendable for a study conducted over a rather limited period, and amounted to a remarkable 50 % of the species known from Sicily. A histogram shows the number of species recorded each month, November being the richest, but a parallel histogram showing how many visits were made in each month over how many years would have been a useful adjunct. The numbers of species recorded in different grid squares varied enormously, from less than 50 to 375 taxa, the richest area being in a central wooded area. But just how rich the area really is must await much more work, but with around 1600 vascular plants present in the same area, studies on all groups of fungi over a much more extended period would be expected to eventually take the total to as many as 8000 species. The whole is well-presented, and I was pleased to see that voucher specimens had been deposited in Herbarium Mediterraneum in Palermo (PAL) – something often not done in macromycete surveys yet essential to substantiate them and ensure their value in decades to come. While this book provides a most useful work to take along with a field guide when visiting or studying in Madonie Park, it will be interesting to see how much more the authors will find in their ongoing exploration of the Sicilian mycobiota (sic 'mycological flora').

ASCOMYCETES

Truffes Blanches et Noires (Tuberaceae & Terfeziaceae). By Joseph Astier. September 1998. Joseph Astier, 19 Boulevard Claude Antonetti, 13821 La Penne sur Huveaune, France. Pp. 127, col. figs 259. ISBN not assigned. Price Ff 390 (+ Ff 40 postage [France]; Ff 60 [Europe]; Ff 70 USA and Canada; Ff 91 [Japan], and Ff 101 [Australia and New Zealand]).

Although Mycotaxon aims to review the latest published works as quickly as possible, an exception is made here for this privately produced volume by an extremely skilled 'amateur' which was submitted only in September 2000. Joseph Astier is well-known as a collector of larger ascomycetes, honoured in Helvella astieri Korf & Donadini 1973 described from France, and is also president of the 'Groupe Mycologique B. Peyronel de Ceva (Piémont)'. An overview of the history and structure of truffles, different views on their classification at the ordinal and family levels, and methods of examination, is followed by standardized descriptions of the 12 genera and 45 species treated in detail; notes are added on some other species not treated in depth.

The major part of this work is the 259 coloured photographs. The number devoted to each species varies, and they show intact and cut open ascomata, peridium and gleba structure, asci, and ascospores. The details of ascospore ornamentation revealed by light microscopy alone are impressive and show just what can be achieved with even a modest microscopic set-up provided one has enough skill and patience. The depth and sharpness of the ascospore photographs even exceed many of those in Montecchi & Sarasini's Funghi Ipogei d'Europa (2000, Mycotaxon 76: in press, 2000), and the work acts as a marvelous companion volume to that work for hypogeous ascomycetes. All those who strive to identify ascomycete truffles would benefit from having this beautiful work at their side.

LICHEN-FORMING FUNGI

Cladoniaceae. By Teuvo Ahti. 3 March 2000. [Flora Neotropica Monograph No. 78.] New York Botanic Garden Press, Bronx, NY 10458, USA. Pp. 362, figs 215. ISBN 0 89327 431 3. Price not indicated.

It is a joy to see this long-awaited monograph by the world's leading authority on the Cladoniaceae in print. With so few groups of lichens in the neotropics yet subjected to critical monographic revisions, this will be a major boost to lichenology in the region. Four genera are treated, Cladia (3 species), Cladina (16), Cladonia (164), and Pycnothelia (1); in total, 184 species are accepted. In general macrolichens are rather well known, so it was a surprise to find that 29 species were described as new to science here, i.e. 16 % - not least because the author had already described many other species as new from the neotropics. This extent of novelty is certainly in no small measure due to the author's personal collections made on extensive visits to Argentina, Brazil, Guyana, and Venezuela, with shorter trips to Costa Rica, the Dominican Republic, Mexico, Paraguay, and Uruguay. This emphasises the need in preparing accounts of lichens for Flora Neotropica to base them on fresh fieldwork and not to merely reassess already reported species. In addition, numerous previously described species are reduced to synonymy and six new combinations are made.

The whole monograph is meticulously researched and well presented. The morphological features are explained, making extensive use of the scanning electron microscope (SEM), and providing the first SEM-level views of surface characters, rhizines, etc. This section will be of interest to all studying the genus anywhere in the world.

Chemical characters are extensively used throughout, and tables of the major and minor compounds present in the species presented. However, 'chemical species' are not accepted unless there are correlation's with other, often 'subtle' characters. His approach is explained (pp. 19-22). Chemical characters are regarded as 'too insignificant for species status', and problems are exemplified by Cladonia peltastica which has more than 10 chemotypes amongst which even the major are 'difficult to define', partly due to some having 'one or a few major (abundant) secondary compounds and additional minor ones in trace amounts'. Ahti's approach needs to be noted by others wrestling with parallel problems in other genera.

Also controversial in the family is the acceptance or not of Cladina as a distinct genus. It is perhaps unfortunate that this work went to press before molecular studies made public last August demonstrated that this was not justifiable.

Keys are provided to genera, sections, and species, and species arranged alphabetically within section. For each species, information is provided on types (with their chemical components), chemistry, distribution, references to illustrations, representative specimens studied, and often comments. Half-tone photographs and distribution maps are provided; the latter often show clear clusters of dots adding confidence to the fact that localizations are real rather than an artefact of collecting patterns. The volume concludes with references (one from 1590), a synopsis of accepted taxa, and a comprehensive index to scientific names.

The value of this work is not limited to the neotropics as a considerable proportion of the species treated also occur either in North America and (or) Europe. This will be a major source for those confronted with difficult Cladonia's world-wide – at least while Ahti's overall world treatment is still in preparation. The monograph is also worth looking at as a model to emulate by lichenologists working on other groups of lichen-forming fungi.

Catalogue of the Lichenized and Lichenicolous Fungi of Slovenia. By Ursula Suppan, Johannes Prügger & Helmut Mayrhofer. 2000. [Bibliotheca Lichenologica No. 76.] J. Cramer, Gebrüder Borntraeger, D-14129 Berlin, Germany. Pp. 215. ISBN 3 443 58055 6, ISSN 1436-1698. Price not indicated.

This the first major reference work on lichen-forming, lichenicolous, and allied fungi to have been compiled for the country since Fran Kušan's monumental Prodromus Flore Lišaja Jugoslavije (1953). It accepts 860 taxa (including infraspecific ones), 787 of which are lichenized species, 39 lichenicolous, and 24 non-lichenized. For each entry, the regions in which species are recorded is indicated, together with literature citations and information on substrata. While it is evident that the lichenological exploration of the country is still at a young stage, not least from the recent contributions of the first author of this work, this will be boon to all lichenologists working in or visiting it and should stimulate further work in this floristically fascinating region.

A Color Guidebook to Common Rocky Mountain Lichens. By Larry L. St Clair. 1999. Monte L. Bean Life Science Museum, Brigham Young University, Provo, Utah 84602, USA. Pp. vi + 242. ISBN 0 8425 2454 1. Price US $ 19.95 (+ US $ 2.50 shipping and handling).

This well-presented book covers almost 200 'common Rocky Mountain lichens'. It is unusual amongst North American guides in that the selection is not restricted to macrolichens but also includes a wide range of the more frequently seen crustose species. The species are arranged by genus, and after a generic description there is a key to species, not all of which are dealt with further. The species entries are whole-page with a description, notes on habitat, chemistry and air pollution sensitivity, and a colour photograph. The whole is prefaced by an introduction to lichen biology, with an emphasis on their use as bioindicators, and there is an ample glossary and substantial bibliography. There are also helpful and pragmatic notes on collection and specimen preservation. Coloured identification manuals are as valuable in the identification of lichen-forming fungi as they are of mushrooms, provided in both cases that the colour reproduction is first rate. Larry St Clair's photographs in general achieve this well, although in some cases they could have been sharper and a few were evidently taken while wet, and indications of magnifications would have been an asset. With its focus on common species and as some crustose species are included, the work will be of value outside the Rocky Mountain region and an especially valuable adjunct to those concerned with environmental monitoring using lichens.

Lichens. By [O.] William Purvis. November 2000. [Life Series.] The Natural History Museum, Cromwell Road, London SW7 5BD, UK. [Distributed by Plymbridge Distributors, Plymbridge House, Estover Road, Plymouth, Devon PL6 7PY, UK.] Pp. 112. ISBN 0 565 091530 0. Price £ 9.95.

An introductory textbook, not a taxonomic work per se, but attention is drawn to it here because it is so beautifully illustrated and bound to capture the imagination of student and seasoned mycologist alike. Nature, structure, evolution, classification, ecology, biomonitoring, dating, economic uses, and practical projects are all covered. Further, the superb photographs are from a wide range of continents and habitats. If you want to encourage someone to take up lichenology, or wonder what the fascination is yourself, connect with a copy of this delightful and yet authoritative book.

BASIDIOMYCETES

A Checklist of the Rust Fungi of the British Isles. By D[ouglas] M. Henderson. September 2000. British Mycological Society, Joseph Banks Building, Royal Botanic Gardens, Kew, Surrey TW9 3AE, UK. Pp. 36. ISBN 0 9527704 4 X. Price £ 4.00.

It is 34 years since Wilson & Henderson's masterly British Rust Fungi appeared (1966), a book I have been taking regularly on fieldwork almost since its publication. This update of the known specie and their names covers 268 species, 14 of which are additions to Great Britain and Ireland since 1966. But this is more than a naked checklist. Information is also provided on the spore stages represented, host plants, and pertinent literature references. This will be welcomed not only by British and Irish mycologists and plant pathologists, but by all uredinologists wanting up-tσ-date information on what is now known in one of the best researched areas for rusts in the world.

YEASTS

Yeasts: Characteristics and identification. 4th edn. By J. A. Barnett, R. W. Payne & D. Yarrow [photomicrographs by Linda Barnett]. August 2000. Cambridge University Press, The Edinburgh Building, Shaftesbury Road, Cambridge CB2 2RU, UK. [Cambridge University Press, 40 W 20th Street, New York, NY 10011-4211, USA.] Pp. ix + 1139. ISBN 0 521 57396 3. Price US $ 320.

This new edition of this now standard practical identification manual scarcely needs any introduction to zymologists. It covers a staggering 678 species (in 93 genera), all for which cultures were available up to November 1998, and for these details are given of 99 physiological tests together with descriptions and 1350 photomicrographs (about 500 used for the first time in this edition). An addendum gives briefer information on 28 further species published after the main text was complete. Extensive tables for identification to species, a register of the almost 4000 yeast names known to the authors (with types, status, and synonymy), glossary, and an enormous bibliography follow. No laboratory concerned with yeast identification can afford to be without a copy. If concerned at the price, consider the size and the cost of the time it can save through facilitating prompt identifications.

MISCELLANEOUS

Taxonomic Literature. Supplement VI. Do-E. By Frans A. Stafleu & Erik A. Mennega. 2000. [Regnum Vegetabile Vol. 137.] Koeltz Scientific Books, D-61453 Königstein, Germany. Pp. vi + 518. ISBN 3 904144 17 0. Price DM 280.

This is a volume I welcomed with some sadness as both authors had died before it appeared; Frans in 1997 and Erik in 1998. Their legacy is, however, a reference work of incalculable value to botanists in the broadest sense, and fully incorporating mycology. Its remit is encapsulated in the subtitle, 'A selective guide to botanical publications and collections with dates, commentaries and types'. For each author there is a biographical sketch, notes on the location of herbaria and types, references to biographical notices, and then exhaustive details of books published including evidence for dates of publication, where copies have been seen, and often notes. Information on later editions is always provided, and of especial value is the dating of particular parts of works issued over a period of years. While the focus is books, some personally edited journals and re-(and pre-)prints from journals are also to be found. The book started as a single volume, Taxonomic Literature by Frans Stafleu published in 1967. It met a need and Frans then went on to collaborate with Richard ('Dick') S. Cowan, who like Frans died in 1997, in a second edition that ran to seven volumes issued over the years 1976-88; this is affectionately referred to as 'TL-2'.

The first volume of the new edition had covered authors A-G, but the fullness of the treatment was less than in later ones. Having completed 'Z', Frans collaborated with Erik in starting a supplement to rectify this; the first supplementary volume appeared in 1992.

I draw attention to this remarkable work here as I continue to be amazed how few mycologists (including lichenologists) seem to be aware of and use it. If you are involved in unraveling and dating parts of publications by authors such as Acharius, Fries, Hoffmann, Persoon, etc., or wondering where the type specimens of less prolific authors might be, opening the pages is a 'must'. That is not to say there are no mistakes or contrary information on datings even in such a meticulously produced and painstaking work. For example, in 1997 I found that part of Hedwig's Desciptio et adumbratio nicroscopico-analytica muscorum frondosum came out in 1788 not 1789 from a copy Hedwig sent to James E. Smith now in the Linnean Society's Library in London. As in matters of synonymy, bibliographic conclusions should similarly always be verified in as far as is practicable.

All concerned with botanical bibliography owe the authors, the sponsors (International Association for Plant Taxonomy, IAPT) and publishers an immense debt for producing such an invaluable reference work of lasting value which also can save so much time and help avoid unfortunate nomenclatural mistakes. All 13 volumes of 'TL-2' (i.e. including the supplements) are still available; make sure you know where you can access a copy ! It is to be hoped that some mechanism eventually be found to complete 'F-G', and so round-off the whole, and I know that the IAPT is very conscious of the need to address that.

Mosses and Other Bryophytes: An illustrated glossary. By [W. M.] Bill Malcolm & Nancy Malcolm. November 2000. Micro-Optics Press, Box 320, Nelson, New Zealand. Distributed by Timber Press Inc., 133 SW Second Avenue, Suite 450, Portland, ORE 97204-3527, USA.] Pp. 220, col. photos 968, line figs 22. ISBN 0 473 06730 7. Price US $ 39.95.

This book is a delight, a model of how glossaries and dictionaries can be presented with modern technology. The skilled colour photography of the authors will already be familiar to lichenologists from The Forest Carpet (1989) and Bill's co-authored (with David J. Galloway) New Zealand Lichens: Checklist, key, and glossary (1997). This book consists of definitions of descriptive, anatomical, ecological, and other terms used in bryology illustrated with superb colour photomicrographs. If you are looking for terms to describe unusual fungal features and don't wish to coin a new one, or need a definition of an unfamiliar descriptive word such as 'mucronulate', 'orgadophilous', or 'prorulate', try this glossary and enjoy the pictures!

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ERRATA

VOLUME SEVENTY-SIX

Page 259, lines 7, 8, 15, and page 262, lines 16, 19, 22, 27, 31, 35, 39, 43
for *pestalotiopsis* read *Pestalotiopsis*

VOLUME SEVENTY-SEVEN

Page 28, line 5	for *metrevoluta*	read *metarevoluta*
Page 29, line 18	for *crenualta*	read *crenulata*
Page 108, line 4	for *Heteodermia*	read *Heterodermia*
Page 146, line 2	for *Melola*	read *Meliola*
Page 268, line 35	for *sancti-angeli*	read *sancti-angelii*
Page 278, line 8	for *Parmeotrema*	read *Parmotrema*
Page 314, line 2	for *Hypoceonomyces*	read *Hypocenomyces*
Page 314, line 7	for *Flavoparmelia soredica*	read *Flavopunctelia soredica*
Page 316, line 32	for *piggottii*	read *piggotii*
Page 318, line 26	for *baltimoriensis*	read *baltimorensis*
Page 319, line 17	for *Mylechroa*	read *Myelochroa*
Page 320, line 2	for *trachyphylina*	read *trachyphyllina*
Page 324, line 14	for *trachophora*	read *trochophora*
Page 330, line 18	for *rosii*	read *rosei*
Page 351, line 3	for *stilligera*	read *stiligera*

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INSTRUCTIONS TO AUTHORS

(revised October 2000)

Mycotaxon is an international journal for articles on the taxonomy and nomenclature of fungi. Publication is open to all persons. The Editor-in-Chief receives camera-ready copy of manuscripts that have been reviewed prior to submission by an expert(s) in the field. The author is responsible for obtaining and documenting peer review of the manuscript, and preparing *camera-ready copy*. It falls to the author to prepare concise, well-formatted copy, free of error, that accurately conveys the author's ideas in an economy of space.

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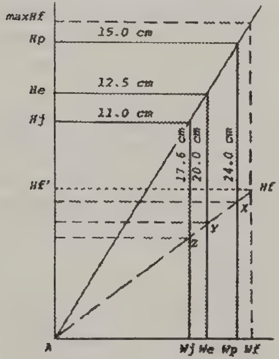

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